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Sławomir AUGUSTYN
Military University of Technology (Wojskowa Akademia Techniczna)

A NEW STRATEGY FOR DEVELOPING OF SPACE LOGISTICS

Nowa strategia rozwoju logistyki kosmicznej

Abstract: *This paper shows a new strategy for developing of space logistics which is supported by safety engineering for the operational techniques and technologies in space. A new strategy is a very important for developing of space technology because account improvement range and its independence from most terrestrial network failures. The developing space logistics is observable during make of satellites which are ensuring wide-ranging continuous information flow among people, businesses and governments for assuring of safety and security when terrestrial network connections are disrupted. The main goal in this publication is presenting example of analysis and assessment in an industrial enterprise of space logistics.*
Keywords: engineering system, space logistics, innovation

Streszczenie: *W publikacji przedstawiono nową strategię rozwoju logistyki kosmicznej wspieranej przez inżynierię bezpieczeństwa w celu poprawy technik operacyjnych i technologii w przestrzeni kosmicznej. Nowa strategia jest bardzo ważna dla rozwoju logistyki kosmicznej, gdyż uwzględnia poprawę zasięgu oraz jego niezależność od powstałych awarii w sieci naziemnej. Rozwój technologii kosmicznej jest zauważalny przy budowie satelitów, które zapewniają wielopłaszczyznowy, ciągły przepływ informacji pomiędzy ludźmi, przedsiębiorstwami i rządami dla zapewnienia bezpieczeństwa w przypadku powstałych zakłóceń połączeń sieci naziemnej. Głównym celem publikacji było przedstawienie przykładowej analizy i oceny przemysłowego przedsięwzięcia dla rozwoju logistyki kosmicznej.*
Słowa kluczowe: inżynieria systemu, logistyka kosmiczna, innowacje

1. Introduction

Global cooperation in science and business, in order to implement innovative logistics technologies in the space industry, give the new rules, behaviours and reaction in changing situational awareness of economic issues. Furthermore, the smart products management in relation to space logistics engineering creates a sophisticated skills and capabilities in developing of innovation space projects within high level of scale economics.

When it comes to the space logistics industry field, they must consider, for instance, that hazards can reduce the safety and constrain the efficiency of our national air navigation system. From the earliest days, it was clear that high-quality weather observations and accurate weather forecasts were critical to the safe operation of an aircraft [10]. It is important to understand how the properties of a satellite engineering system can be used to better improve the space logistics applications, including, not only real-time weather data information, but also navigation, communication, tracking and flight management. The future suggests that many of these powerful trends will continue and space logistics technologies indicate that several decades of continuing innovations are currently possible.

The definition of safety engineering for space logistics in innovative fields of engineering systems that enterprise deals with accident prevention reducing the risk associated with human factors and technical errors in order to derive safety and security benefits from modern engineered systems and space technologies design. It is associated with innovation industrial engineering with intelligence system to be applied to modern manufacturing, products design, social and public works in order to make safety and security an integral part of operations [13].

Above all the most important is new space innovation technologies within interaction between social and business trends. The future of logistics in space trucking and maintenance will be integrating smart sensors in process making decision in order to identify time and space place positions in universe [11]. This intelligent solution in space services enable effective delivery of spare parts to e.g. satellites, shuttle etc. just in time.

International cooperation is essential to move the technological innovation community. The scientific and technological research relates to a priority giving increased efforts for international investments. This will impact support of modern industry by strengthening critical skills and professional expertise. Innovation logistics technologies management in space offers an exceptional opportunity for academia and the private sector too, including small and medium enterprises (SMEs) in the following aspects:

- business-to-business (B2B) in space consultancy and mentorship,
- mediation business-to-consumer (B2C) for partnerships,
- support for innovation space project execution in business-to-costumer (B2C),
- support in consumer-to-consumer (C2C) by intellectual property rights (IPR).

The innovation and professional development in space business should participate in international consortia and could be granted of their research and development (R&D) links and innovation expenditures by the leaders-coordinators [7].

The leaders-coordinators of innovation space projects should launch generous support and financial B2C mechanisms with IPR issue. The intent of coordinators consists of organizing meetings consortium which participate in projects. One example of innovation projects could be writing workshops which have their proposal either written or pre-evaluated by space professional experts.

For this reason, collaboration between Universities, industrial space players, SMEs, researchers, public and non-governmental organization organizations and investments support and innovation promotion should be a high priority for increasing the visibility of opportunities in management of space logistics innovation. The most significant space logistics innovation could be implementing mutual technical constructions, agriculture and transportation in space. The focus would be to create new business models in banking and pursuing based on big data, social media, and the Internet of Things (IoT) [7].

These benefits from new logistics advances can be achieve by the integration of internet based modern technologies and services into fully wired communities. These intellectual ventures are created by urban space hubs with supplying consumers e.g. astronauts, satellites and space stations in safety equipment, technical and medical services [9]. Furthermore, these service aspects recognize opportunity logistics support by build customized models with risk assessment based on information collected from on line activities of international modern industry in space exploration.

2. The changes in the space logistics trends

The space logistics trends are very dynamic in innovation living technologies e.g. robotics, IoT which influence on development of business and standard of society. It is becoming an inspiring benchmark for innovation strategy in the logistics space industry. It has triggered a number of successful collaborations with customers and partners in deriving innovation logistics solutions all over the word.

Furthermore, there is potential to shape the future from the adaption of self-learning systems to leverage the possibilities of smart energy space logistics. By turning research into good practice, companies can secure first hand insight on potentially game-changing trends. Key technologies will become powerful in logistics innovation which will be followed closely by business and social aspects in the near future. Furthermore, entrance in-depth of technology trends also contains an analysis of space logistics sectors based on innovation knowledge though a professional approach of experts in engineering and manufacturing domain related to consumer like life sciences. Innovation machines join the logistics work force not only trough self-driving vehicles and IoT but also Augmented Reality (AR) in the environmental area of machine-human (anthropo-technical system) interaction and collaboration in space logistics systems [1].

The next smart technology is in the area of robotics and automation by intelligent robots with connected to Information Technology (IT) programs and lighter and more flexible to work side-by-side with qualified employees. The intelligent robots can support

repetitive and dangerous, physically demanding tasks of humans in logistics operators. There is transforming power action including offline and online of new technologies in a tangible modern industry through the smart omni-channel logistics.

Innovation in space logistics creates more dynamic delivery options as well as satisfactory services at an economical level forwards fair and responsible supply chains.

For example, satellite communication by fair phone focuses on supply chain to highlight consumers who demand for fairer products. Therefore, it is good transparent such as sustainable solutions in consumption environmental challenges and intelligent digitalization innovation products by identify and evaluate sources of inspiration.

Furthermore, the security awareness in cloud logistics brings reduced security risks which becomes a high priority to avoid harmful attacks in increasingly IT system for reaching supply chains e.g. sustainable energy. That is why there is a growing importance in cyber security happens significant element in good operational logistics services. Additionally, transformational space logistics requirements have also given rise to growing e-mobility solutions and renewable energy sources, such as solar, water power, wind power to help decentralize energy supply chains by reducing volumes of fossil fuel transportation.

Moreover, the ultimate vision for these platforms can be a new super grid, coordinating multiple marketplaces through logistics interface. For example, the new start-ups are unbundling the logistics industry by the development of innovative freight transportation with warehousing and fulfilment, express delivery solutions.

One of these solutions is the development of the 3D printing market that can use innovative critical technology for prototyping and series production. The cost interoperability and intelligent computer's applications are being used to help grow the space market which is providing opportunities to contribute to the future e.g. feedback from the global logistics community (Near & X-sharing).

For example, smart energy and modern hub and tube infrastructures in logistics will be propelled by e-mobility with harvesting technological progress in driving systems for space cargo transportation. The logistics technology trends (tab. 1) cover a broad variety handling, intelligent supply chains and highly automated produces with delivering application (tab. 2) in social & business issue.

Table 1

The logistics technology trends [7]

Impact trend	Logistics technologies	Implementation period
High	Self-Driving Vehicles, 3D Printing	≤ 5 years
	Big Data, Internet of Things, Robotics & Automation, Cloud Logistics	≥ 5 years
Medium	Unmanned Aerial Vehicles, Self-learning Systems, Bionic Enhancement	≤ 5 years
	Augmented Reality, Low-Cost Sensor Technology	≥ 5 years
Low	Digital Identifiers	≥ 5 years

Table 2

The logistics social & business trends [7]

Impact trend	Logistics technologies	Implementation period
High	On-demand Delivery, Omni-Channel Logistics, Anticipatory Logistics	≤ 5 years
	Super-Grid Logistics, Logistics Marker Places	≥ 5 years
Medium	Smart Energy Logistics, Shareconomy Logistics, Fair & Responsible Logistics, Convenience Logistics, De-Stressing the Supply Chain	≤ 5 years
	Grey Power Logistics, Batch Size One	≥ 5 years
Low	Multi-Purpose Networks	≤ 5 years
	Tube Logistics	≥ 5 years

Advance technologies in the space logistics domain is helping to create e.g. digital health records, tract medical supply levels, improve supply chains in space missions covered by geographic information systems. This potential of space logistics provides more innovation technologies which can help to change human lifestyle.

The space logistics sector is currently in the transition phase, from being funded mostly by the public sector to raising funds from private shareholders and from being a purely research-oriented activity to implement commercial venture with such successful applications as satellite-based mobile communications. This state of transition creates unrest, since structures are transformed, alliances modified, users become customers and their requirements change and must be satisfied quickly in industrialized societies.

3. The changes of space technology logistics systems in the future

In the last fifty years, satellites played a key role in the growth of global communications, transportation, media and technology industries. During this period of time satellite communications grew to a 100€ billion space industry, enabling breakthroughs like intercontinental telephony, live television from remote regions, the broadcasting of television channels to all citizens, global positioning, trunking for telecom operators and reliable data networks for private companies e.g. by supporting space logistics [12]. In recent years, satellite technology has seen a significant leap in advanced technologies. Multi-spot beams allow for much higher throughput and lower costs and are using frequencies even more efficiently of intelligent supply chains.

When it comes to the aeronautical sector, it is only recently that this community has started to appreciate the real value of space logistics systems. It is true to say that a golden opportunity was missed to take up the service in the 90s when it was first introduced. Claims that the service was too expensive are belied by the fact that the huge resources demanded in both manpower and equipment for high frequency voice operations were never entered into the equation. Another consideration was an attachment by the air traffic services authorities and to a lesser extent the aircraft operators, to the glamour and enthusiasm associated with the uncertainty of high frequency. Air traffic services authorities were also slower to embrace satellite communications than the airlines who, very early on, recognised the usefulness of reliable data communications for aircraft system monitoring and operational management. There is little doubt that undue emphasis on voice services and the much higher power and antenna gain requirements for these services delayed the uptake [8].

The advent of satellite services has revolutionised aircraft management for aircraft operators, particularly since the introduction of condition-based maintenance of aircraft engines and other systems. Very soon, with the increased take up by space traffic control authorities of satellite communication, navigation and surveillance systems, flights in space and other remote areas will be able to operate much more efficient logistics, saving large amounts in smart energy and appropriate time. This will be achieved with a level of safety considerably higher than is available with the necessarily wasteful and conservative separations of today.

The commercial space logistics industry is clear on major changes of quality for customers with existing technology that will require sophisticated, high-performance connectors that meet the challenges of in-flight controls and communications.

Recently, space companies have been working to improve the efficiency of automobiles by deploying the so-called eco-routing or ”green Global Positioning System (GPS)” navigation systems in logistics cars. Like other automotive navigation systems, these systems use distance and average speed to calculate the “shortest” and “fastest” route from point A to point B. However, they also consider additional factors in order to provide the ”greenest” or most energy-efficient route. Some of these eco-factors are [7]:

- Stoplights and stop signs: avoid stopping;
- Traffic: avoid stop-and-go, idling, and very low speed;
- Curves: avoid deceleration and re-acceleration.

These modern logistics technologies in space industry will be used by local intelligence for monitored localization consumer's products.

In the future the space logistics systems and innovation manufacturing will change by increasing quality in real-time services, just in place like urban logistics, and just-in-time for product personalization. This space logistics strategy will be adapting to consumers by intelligence supply chains e.g. modern approach postponement and safety, quickly delivery services. The changing logistics systems will cooperate with crypto-currencies and crypto-payment which will create a new potential development in innovative space business. Therefore, a new development logistics systems contain relevance with implementing very high technologies such as the IoT, cloud space logistics and digital identifiers [11].

In the broad world's perspective, there is a lot to change in my opinion. From better supply systems and processes to utilizing artificial intelligence for coordinated efforts, additive manufacturing to build parts in the field, and drone or autonomous resupply to get items to soldiers faster and safer.

I would like to believe that nations will try their best to protect human potential by building unmanned vehicles and aircraft which will lead to less loss of life. Another benefit by developing unmanned vehicles is their capability of logistic transfer of materiel and ammunition. That is important if an Army wants to endure in a fight and not withdraw after a few hours due to lack of ammunition [11].

Concerning the Internet of Things, the biggest threat for our generation and the ones following, due to the connectivity of everything, information, communication, location, etc. It is vital to protect our Cyber space to maintain the availability of modern means of communication, etc. If satellites can be destroyed, our society would have to go back to older methods of communication and sharing information.

4. An example of analysis and assessment in an industrial enterprise

The X company is an industrial - production and commercial enterprise dealing in the production of parquet. It is a family company, one of the largest producers of wood products in eastern Poland. The main sales market is the domestic market (approx. 75%), but the goods also go to Russia (15%) and Germany (10%). The company's operations are subject to many risks. For this reason, each new situation and emerging development opportunity should be analyzed and evaluated. A comprehensive method that investigates the situation and aims to make the right decision is SPACE analysis.

The SPACE (Strategic Position and Action Evaluation) method is similar to the SWOT analysis and is used to determine the strategic position and activity of an enterprise. It

focuses on the risk that may inhibit the company's development. It is used specifically when making decisions regarding business diversification. It consists in four areas determining the company position, together with the determinants that characterize them (tab. 3).

Table 3

The areas determining of the company position

Outside area	Internal area
Industry Strength (IS)	Financial Strength (FS)
Environmental Stability (ES)	Competitive Advantage (CA)

Tables 4-7 presents individual strategies and criteria selected for them. The weights were then determined and the appropriate grades assigned. On this basis, weighted averages were calculated for individual criteria and strategies.

Table 4

Assessing the industry strength

Criterion for assessing the industry strength	Factor weight	Rating (1÷6)	Weighted rating
Resource use	0,3	5	1,5
Profit potential	0,1	4	0,4
Capital increase intensity	0,2	3	0,6
Easy to enter the market	0,15	4	0,6
Productivity	0,25	5	1,25
Sum	1	X	4,35

Table 5

Assessing the environmental stability

Criterion for assessing the environmental stability	Factor weight	Rating (-6÷-1)	Weighted rating
Changes in technology	0,2	-1	-0,2
Inflation rate	0,1	-3	-0,3
Product price level	0,35	-2	-0,7
Market entry barriers	0,15	-4	-0,6
Competition intensity	0,2	-3	-0,6
Sum	1	X	-2,4

Table 6

Assessing the financial strength

Criterion for assessing the financial strength	Factor weight	Rating (1÷6)	Weighted rating
Return of investment	0,2	5	1
Financial Liquidity	0,35	4	1,4
Working capital	0,05	4	0,2
Easy to change the market	0,25	5	1,25
Industry risk	0,15	3	0,45
Sum	1	X	4,3

Table 7

Assessing competitive advantage

The criterion for assessing competitive advantage	Factor weight	Rating (-6÷-1)	Weighted rating
Market share	0,1	-1	-0,1
Product quality	0,4	-2	-0,8
Product life cycle	0,25	-2	-0,5
Consumer loyalty	0,1	-3	-0,3
Supervision of supplies and distribution system	0,15	-2	-0,3
Sum	1	X	-2

After calculating the average values of financial strength (FS) points, competitive advantage (CA), environmental stability (ES) and industrial strength (IS), the average values of points (IS) and (CA) as well as (FS) and (ES) were added .

Thus, on the axis OX = IS + (-CA), and on the axis OY = FS + (-ES). Then a straight line was drawn from the beginning of the coordinate system to the point resulting from the intersection of two lines from the OX axis and the OY axis. That is, for OX = 4.35 + (- 2) = 2.25, and for the axis OY = 4, 3 + (- 2.4) = 1.9. The resulting line connecting the origin of the coordinate system with this point is a directional vector illustrating the type of recommended strategy for the analysed enterprise (fig. 1).

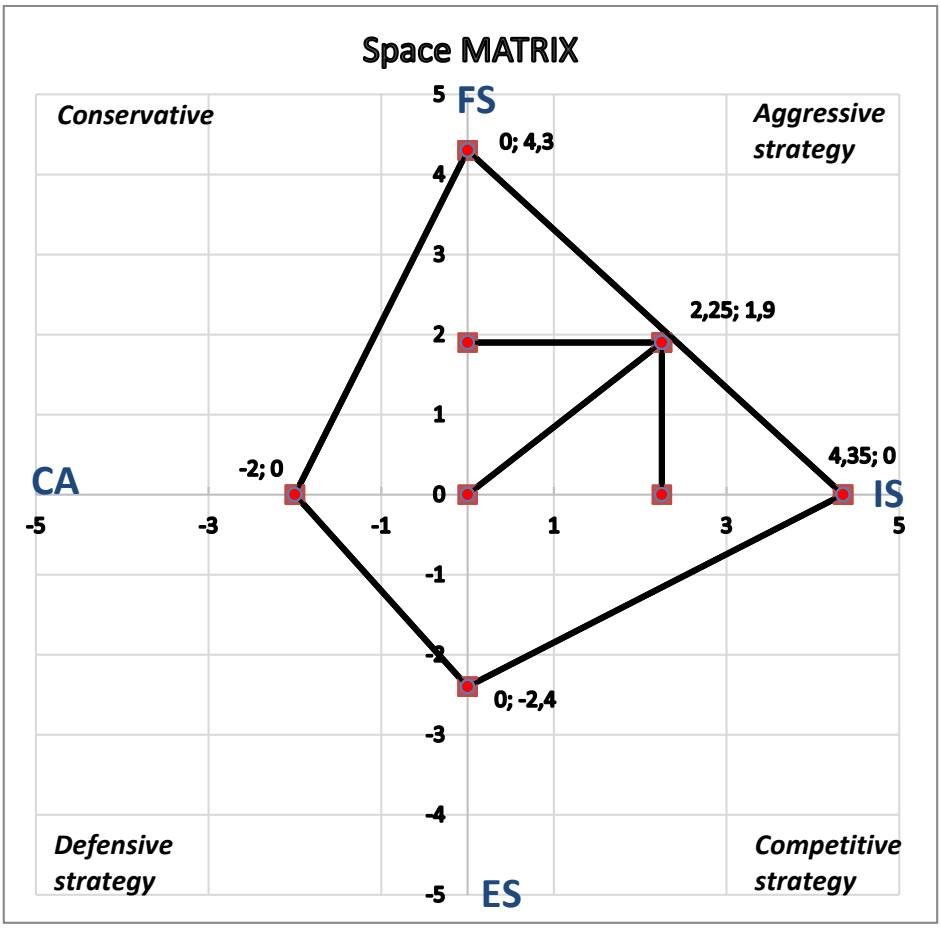

Fig. 1. The Strategic Position and Action Evaluation analysis

The analysis shows that the space company operates on an attractive market, in a stable environment and is characterized by a strong position and significant competitive advantage. This is an example of an aggressive strategy, which should be aimed at developing or maintaining a strong market position, which requires the involvement of larger financial resources and making certain investments.

5. Conclusions

In summary the management of innovative logistics technology in space is a period of global cooperation dynamic change. Especially in space services segments, the logistics offers a new reactive approach to innovative technologies.

In addition, the structural changes of intelligence systems such as big data analytics, the internet of things, and self-learning systems to digitalize space logistics in order to enhance interaction between quality services for modern business models and customers by e.g. 3D printing for impacting goods transportation.

The implementation of practical applications in supply chains on the basis of cyber-physical systems like autonomous UAV, e-mobility vehicle and e.g. intelligent containers is highly important. Management in space logistics will become a new, interdisciplinary area of research and development programme relate to economics and engineering systems covered by intellectual property frameworks.

The more fundamental issue in the future of logistics global communication between the interaction of human and intelligent machines in industry. Intelligent machines will approach like humans and will be able to make process decisions. However, the ethics issue in roles and responsibilities in sharing decision-making between humans and intelligent machines should be investigated further.

These sources enable us to build a holistic view of the future of logistics in different perspectives with changing the manufacturing industry. Furthermore, the changing development in innovation future and implication relevance projected in the space logistics sector should be based on the opinions of logistics scientists and experts. Thus a new business opportunity in logistics as well as more sustainable space logistics services is driving in new requirements of space handling.

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