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SOCIOTECHNICKÉ TRANSFORMACE V ROZVOJOVÉM SVĚTĚ
Vysvětlení cesty íránského obranného průmyslu

SOCIOTECHNICAL TRANSITIONS IN DEVELOPING WORLD
Explaining the Pathway of Iran's Defence Industry

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Abstrakt

Tento příspěvek se snaží poskytnout sociotechnický výklad transformace íránského obranného průmyslu v posledních několika desetiletích. Se zaměřením na zbrojní průmysl orientovaný na protitankové zbraně je analyzováno trojí období přechodu íránského obranného průmyslu k víceúrovňovému systému na základě Bourdieuho třístupňového modelu. Výsledky ukazují, že nejdůležitějším faktorem obranného průmyslu je rovnováha a koordinace mezi technickým kapitálem a symbolickým kapitálem konstruktérů.

Abstract

This paper tries to provide a socio-technical interpretation of Iran's defence industry transition over the past few decades. Focusing on anti-tank industries, we will elaborate on the threefold periods of transition in Iran's defence industry to a multi-level system by means of Bourdieu's triple levels of inquiry. The results indicate that the balance and coordination between the technical capital and the symbolic capital of engineers is the most important factor in the defence industry.

Klíčová slova

Víceúrovňová perspektiva; obranný průmysl Íránu; protitanková raketa; habitus; sociotechnická transformace.

Keywords

Multi-Level Perspective; Defence Industry of Iran; Anti-Tank Missile; Habitus; Sociotechnical Transition.

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INTRODUCTION

Defence industries are among the leading and productive sectors of each country in the field of science and technology and they affect other industries as well. Efforts toward development and improvement of defence industries and technologies have always changed throughout the history of human civilization.[1] These industries are the core instruments that fulfil the strategic goals and must be at the forefront of technology innovation in order to accomplish their mission.[2]

This paper tries to provide an explanation of formation and transition in Iran's defence industry in the last 50 years. With a glance at this transition path, we can see that the defence industry of Iran before the 1979 revolution was formed under the military doctrine of NATO and its technical achievements were limited to utilization of assembly lines and repair and maintenance functions.[3]

After the 1953 coup, Mohammad Reza Shah accelerated efforts to transform Iran into a Westernized and dominant regional power. One of his top priorities was to build a strong military, leveraging close ties to the United States during the Cold War. Funded by increasing oil revenues, the army acquired a wide range of advanced weapon systems during the 1960s and 1970s, primarily from the United States. At the time of the revolution, its military was one of the most capable in the region, with more than 400,000 personnel.[4]

Since the beginning of 1970s onward, Iran purchased a series of diverse and different new military expensive products from various countries. USA, in line with Nixon's doctrine, was the most effective factor in provision of these needs. Still, Shah took great advantage of the army relying on its modern military appliances in developing his own foreign policy. For strengthening the loyal army, almost 20 percent of the national revenues were spent

[1] LEE, Jun Gon – PARK, Min Jae. Evaluation of technological competence and operations efficiency in the defense industry: The strategic planning of South Korea. *Evaluation and Program Planning* [online]. 2020, Vol. 79, ISSN 0149-7189 (Print). DOI: 10.1016/j.evalprogplan.2019.101775. Available from: https://bit.ly/37UBMQL; CEPIK, Marco - FREDERICO LICKS, Bertol. Defense policy in Brazil: bridging the gap between ends and means? *Defence Studies* [online]. 2016, Vol. 16, No. 3, pp. 229-247 ISSN 1470-2436 (Print). DOI: 10.1080/14702436.2016.1180959. Available from: https://bit.ly/3oIBUd0.

[2] JARA OLMEDO, Anibal - QUISIMALIN, Mauricio - CHAVEZ, Danilo. University–Industry Collaboration Barriers: Project Management Solutions for Defense R&D—A Case Study [online]. *In*: SPRINGER, Singapore. *International Conference of Research Applied to Defense and Security*, 2020, pp. 431-441. 2020, [Cited 2020-11-30]. Available from: https://bit.ly/3qKURgR ISBN: 978-3-319-78605-6 (online). DOI: 10.1007/978-981-15-4875-8_38; SÖNMEZ, Alper. The Importance of Defense Industry in Turkish Economy [online]. *In*: International Institute of Social and Economic Sciences, *Proceedings of International Academic Conferences*, 2019, [Cited 2020-11-30]. Available from: https://bit.ly/2KgKVuU.

[3] An interesting point for the Czech readers of the *Obrana a strategie* journal is that for many years the main rifle in Iran was a weapon called "Brno", made in Czechoslovakia.

[4] Defense Intelligence Agency. Iran Military power. 2019 [Cited 2020-11-30]. Available from: www.dia.mil/Military-Power-Publications

on this force and, in line with this, the best logistic equipment was provided for this force.[5]

However, after the revolution and in the critical duration of war and sanctions, considerable growth in technological capabilities took place, and production of rather advanced systems and technological innovations became possible.[6] Hence, understanding the development of advanced military industries and technological innovations in Iran's defence industry in the 1980s and 1990s is significant, especially when considering various obstacles that Iran's industries were confronted with during this period. After the 1979 revolution, Iran lacked a modern development-oriented government; there was no capital accumulation nor entrepreneur/creative groups and the country lacked required infrastructures for achieving advanced industries and having constructive interaction with the world outside. This situation mainly stemmed from the post-revolution environment as well as the war.

In order to study this transition, we can look into different industrial flows growing in the defence industry and examine each of them to reveal various specifications of the transition. The industrial flow which this paper is centred on is the anti-tank industry. Formation and transition of this industry is important because in its development period in Iran, the level of anti-tank technology system was very high. The TOW anti-tank missile entered US army in 1970 and has been an advanced and complicated weapon since then. Its platform has remained part of NATO's weapon systems till now. This system has been developed in Iran in a rather short period (about 10 years) while there was no former practice, no foreign cooperation nor any required industrial infrastructure. Since then, this system has experienced important innovations.

The most appropriate framework which can explain transition using social and technical elements is the Multi-Level Perspective (MLP). This framework examines transition in a sociotechnical system through interactions between three levels: regime, landscape and niche.[7] Since this framework is designed for the developed countries, there are some issues making use of it in developing countries. As it will be clarified in section 2, before considering the multi-level system transition in developing countries, we must study how transition to a multi-level system happens.

In order to do this, we have used Bourdieu's action theory[8] with key concepts such as field, habitus, capital, and hysteresis as the theoretical framework. To analyse transition in Iran's defence industries, formal documents of the industry were collected and oral

[5] ABEDI GONABAD, Reza. The role of militaristic policies of Mohammad Reza Pahlavi in Victory Of Islamic revolution. *Journal of Economic and Social Research* [online]. 2019, Vol. 18, No. 4, pp. 497-510. ISSN 1302-1060 (print). Available from: https://bit.ly/37aLyyQ.

[6] CZULDA, Robert. Defence industry in Iran–between needs and real capabilities. *Defense & Security Analysis* [online]. 2020, Vol.36, No. 2, pp.201-217. ISSN 1475-1801 (print). DOI: 10.1080/14751798.2020.1750184. Available from: https://bit.ly/3oAQ4Nc.

[7] GEELS, Frank. From Sectoral Systems of Innovation to Socio-Technical Systems: Insights about Dynamics and Change from Sociology and Institutional Theory. *Research policy* [online]. 2004, Vol. 33, No. 6-7, pp. 897-920. ISSN 0048-7333 (print). DOI: 10.1016/j.respol.2004.01.015. Available from: https://bit.ly/3773MS4.

[8] BOURDIEU, Pierre. *The Logic of Practice*. Stanford University Press, 1990. ISBN-13: 978-0804720113.

history of anti-tank missiles was gathered through interviews. Then, based on the transition levels, transition analysis has been described in three stages.

RESEARCH THEORETICAL FRAMEWORK

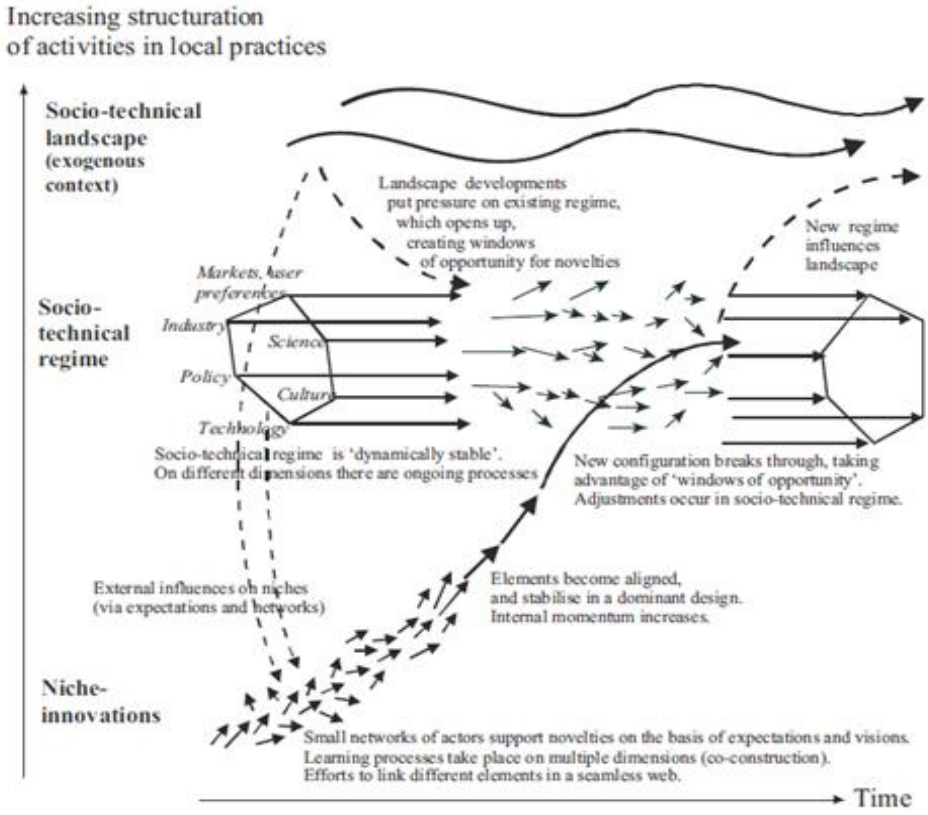
A review of the Multi-Level Perspective (MLP)

Sociotechnical transitions or systemic innovations are large-scale transformations in various systems of society such as transportation, communication, housing, feeding. These systems have specific functions in social life and respond to specific needs of modern society. They are formed around a set of evolving technologies and artifacts, and different social groups are interacting within them. In sociotechnical transitions, technology and technological artifacts along with social elements encounter fundamental changes.

One of the recent and major theoretical frameworks, developed to explain the complex and multi-dimensional aspect of transition in sociotechnical systems, is the multi-level perspective. The MLP views transitions as non-linear processes that result from the interplay of developments at three analytical levels: niches (the locus for radical innovations), socio-technical regimes (the locus of established practices and associated rules that stabilize existing systems), and an exogenous socio-technical landscape.[9]

[9] GEELS, Frank – SCHOT, Johan. Typology of Sociotechnical Transition Pathways. *Research policy* [online]. 2007, Vol. 36, No. 3, pp. 399-417. ISSN 0048-7333 (print). DOI:10.1016/j.respol.2007.01.003. Available from: https://bit.ly/2W2tSiR

Figure 1: Multi-level perspective and transitions



Source: GEELS, Frank 2005[10]

Figure 1 represents an ideal form of dynamic interactions of the three levels for the transition to occur. Despite lots of positive insights regarding this framework, there have been some criticisms, which are divided into 7 categories by Geels. He has responded to these criticisms and when criticism has been substantiated, he has offered some suggestions,[11] which we used in the following section.

[10] GEELS, Frank. *Technological Transitions and System Innovations: A Co-Evolutionary and Socio-Technical Analysis*. Edward Elgar Publishing, 2005. ISBN: 1 84542 009 8.

[11] GEELS, Frank. The Multi-Level Perspective on Sustainability Transitions: Responses to Seven Criticisms. *Environmental Innovation and Societal Transitions* [online]. 2011, Vol. 1, No. 1, pp. 24-40. ISSN 2210-4224 (print). DOI: 10.1016/j.eist.2011.02.002. Available from: https://bit.ly/376Uq8W

Multi-level Perspective and Sociotechnical Transitions in the Developing World

As mentioned in the introduction, we try to use MLP to explain transitions in sociotechnical systems of developing countries; but we keep in mind that this approach has been developed for transitions in developed and industrial countries. In industrial societies, sociotechnical regimes are formed through a historical process within an original and indigenous context. According to MLP, these regimes change by the pressures coming from the landscape level as well as the opportunities emerging in the niche level. But in developing societies, regimes are formed by technology transfer processes and follow-ups, thus technologies are hardly internalized in them. These countries scarcely have active niches interacting with the regime that can result in deep innovations. But in industrial societies there are numerous niches that foster radical innovations mainly due to expanded R&D spaces, entrepreneurs and competitive environment.

Instead of being bottom-up and arising from opportunities provided by niches, transitions in developing countries are more a top-down process. This means, first under the influence of political and social factors the sociotechnical system is transferred and thereafter technological capabilities grow in them from primary levels to advanced ones. In few cases, there are also niches that have the capacity of fostering innovations, which can lead to bottom-up transformations. Thus, in order to understand transition in developing countries, we have to review different stages of the sociotechnical system life cycle in these countries. These stages are:

-Stage one: The macro process of technology transfer and formation of a sociotechnical system. For instance, how a sociotechnical regime like vehicle-based transportation is imitated in a developed country. If the transfer process is more about consumption and exploitation of imported technologies, more social transition/transformation will happen. It means that technology has entered the society and has changed people's lives and has provided them with the opportunity to develop new firms and industries and/or change the existing ones. In this stage, technical changes and innovations are transferred in developing countries with a delay. Hence, the history of sociotechnical change in this stage is more a history of consumption and exploitation of technological artifacts, and little attention is paid to technology internalization and technological capability building.

-Stage two: Technological capability development from initial levels to incremental innovations within the regime; in this stage, institutions and technical routines grow and the regime will have indigenous sources of innovation. The history of sociotechnical systems in this stage is a history of learning and technological catch-up toward industrialization.

-Stage three: In case niches have been developed significantly, the regime will benefit from niche-based radical innovations. The history of sociotechnical change in this stage is a history of innovation. In this stage, a multi-level system has been shaped by interaction of different levels of transition.

Before entering the third stage and while a system has not yet been formed, different stakeholders try to define sociotechnical rules within the system according to their own resources, mindset, and interest. Hence, we need to use a framework which highlights agency more than the structure and role of actors, especially technical and political elites. Of course, this concern is not limited to the first and second stages; also, in the third stage, when sociotechnical system has been established and structures have shaped

the analytical framework, the role of agency should be stressed in order to present an acceptable description of transition. This issue has been raised by critics of the framework and it is suggested that MLP should pay more attention to agency, power conflicts and cultural elements.[12]

Hence, theoretical framework needs to elaborate transition to a multi-level system with the underlining role of agency, power conflicts and cultural elements, and to this point, Bourdieu's action theory can be very helpful.

Bourdieu's action theory implications

Bourdieu's action theory entails several concepts, the most important of which are field, habitus, capital, and hysteresis. A field is a structured system of social positions - occupied either by individuals or institutions - the nature of which defines the situation for its occupants. Importantly, the existence of a field presupposes, and in its functioning creates, a belief on the part of participants in the legitimacy and value of the capital that is at stake in the field. As bounded and highly structured spaces, the fields of higher education and of nursing, with their economic, political and cultural context, therefore generate rules and actions that prescribe and objectify a 'logic of practice'.[13]

According to Bourdieu,[14] the reproduction of the social structure results from the habitus of people. He defines habitus as a system of lasting and transposable dispositions that, integrating past experiences, functions constantly as a matrix of perceptions, appreciations and actions and enables the achievement of diversified tasks.[15] There is a loop between the habitus and the field, i.e., the field is defined according to the habitus and vice versa. Something similar to the relation of paradigm and scientific community in Cohen's theory. Consequently, although habitus is the outcome and function of the fields which people are in, on the other hand, people can change the field with their habitus.

According to Bourdieu, capital includes all the goods, material, and symbols, without distinction, that present themselves as rare and worthy of being sought after in a particular social formation. He distinguishes three forms of capital: social capital (resources based on group membership, relationships, or networks of influence and support), cultural capital (forms of knowledge, skills, education, and advantages that give a person a higher status in society), and economic capital (command over economic resources: cash and assets). Capital must exist within a field for it to have meaning and participants to associate with it.[16] Our focus in this paper is technical capital. Technical capital is a combination of material, scientific, and cultural capital and refers to the ability to understand and the skill of using science and technology in production and innovation processes in order to realize customer's needs.

[12] GEELS, ref. 11

[13] BOURDIEU, Pierre. *The Logic of Practice*. Stanford University Press, 1990. ISBN-13: 978-0804720113.

[14] BOURDIEU, Pierre. Habitus in *Habitus: A Sense of Place*. Routledge, 2017, pp. 59-66. ISBN: 9780754645641.

[15] BOURDIEU, Pierre – PASSERON, Jean-Claude. *Reproduction in Education, Society and Culture*. Sage, 1990. ISBN: 9780803983205.

[16] CHELEEN, Mahar – HARKER, Richard – WILKES, Chris. The Basic Theoretical Position. *In An Introduction to the Work of Pierre Bourdieu*. Palgrave Macmillan, 1990, s. 1-25. ISBN-10: 0333524764.

Bourdieu mentions that the position of people and groups in social environments will be defined by the combination of their capital and the path and time of change in the capital. Of course, and in opposition to Marx, who only considers economic capital, Bourdieu names different capitals such as economic and physical capital, social capital, technical capital, scientific capital, symbolic capital, and cultural capital. For our purpose, in this paper we put stress on the concept of technical capital, which is a combination of physical, scientific, and cultural capital, and refers to the understanding and application of science and technology in production and innovation processes to answer customers' needs.

In Bourdieu's perspective, actors containing regime and niche are in a field which is affected by outside forces (such as other fields and especially power fields and government). Bourdieu refers to this mismatch or disjuncture between habitus and field as hysteresis. In such cases, individuals' "dispositions become dysfunctional and the efforts they make to perpetuate them help to plunge them deeper into failure". These forces can create hysteresis, which may lead to a transition in the field. The notion of hysteresis, then, highlights the disparity between the new opportunities associated with the field change and agents whose habitus leaves them unable (temporarily, at least) to recognize the value of new positions. Hence, hysteresis provides a means of linking the objective nature of the field change with the subjective nature of individual responses.[17]

For studying the field of research, Bourdieu presents three distinct levels of inquiry: 1) the position of the field within other fields, especially power and government fields; 2) mapping the objective structure of relations between positions occupied by those who occupy 'legitimate' forms of specific authority in the field; 3) exploring the habitus of the agents.[18] This is achieved in this research by applying oral history and expert analysis.

The Research Method

The present study has been conducted using qualitative approach and it has tried to provide a historical and sociological analysis of Iran's defence industry development. We used Van de Ven's[19] participative scholarship approach to answer the research question. This approach is widely used to understand the processes of change and innovation and has been broadly utilized in the field of innovation studies.

The study of change processes is based on the conceptualization of events in the form of a narrative. Events are movements performed by actors with specific identities, motivation and interests and change over time. In this context, consequences are created by a series of events. The narrative is not merely a descriptive account of what happened, but is based on selected analytical themes. As in all qualitative research, in this paper, a substantial part of the information is obtained through interviews with informed managers and experts.

In this study, several criteria have been used to improve validity, including:

[17] GRENFELL, Michael. *Bourdieu: Key Concepts*. Routledge, 2008. ISBN: 1- 84465-530-X.
[18] BOURDIEU, ref. 13
[19] VAN DE VEN, Andrew H. *Engaged Scholarship: A Guide for Organizational and Social Research*. Oxford University Press on Demand, 2007. ISBN-10: 0199226296.

1. Involvement and participation of researchers and close relationship with daily experience of the field
2. Approving the findings by experts and receiving and applying their points of view in the study
3. Collecting and applying the opinions of other researchers in the field

TRANSITION ANALYSIS IN DEFENCE INDUSTRY OF IRAN

As per Bourdieu's three level of inquiry methodology and triple stages of transition, formerly described in the socio-technical system section, in this section we study the transition in the defence industry of Iran by focusing on the anti-tank missile industry:

THE FIRST WAVE: the Last Decade of the Pahlavi Government (1970s)

The Position of the Industry Field in Contrast with the Government Field

The defence industry field has more interactions with the government field and political system than any other fields. The function of the defence industry field is that of technological support for the army and military system which is formed under the government; in other words, defence industries provide the government with the hard power. To understand the way hard power was shaped in this period, we shall consider the political field and its fluctuations. Rentier structure based on oil incomes, dependence on USA, rapid development policy, king's ambitions, instability of the middle east, Cold War and USA's military doctrine (which expected promotion of Iran's place in the security structure of the Persian Gulf), all of these helped Iran's growth in defence industries. In this period, the army's growth was noticeably high to the point that in 1987 it had personnel of 410 thousand. Iran's military doctrine along with NATO's doctrine had clear strategies for the army, navy, and air forces, and Iran bought 19 billion USD worth of weapons from USA during 1972-1979.[20] This situation led Iran to rapid imports in defence industries. In this period, many production lines and maintenance facilities were transferred to Iran with turn-key contracts. Even about 10 thousand housing unit were built for the employees and counsellors of the defence industry by western contractors.

Another characteristic of the defence field in this period was its isolation from other industries in Iran. The defence industry was technologically superior to other industrial and production sectors of Iran, due to its foreign structure and origin; hence, it did not have any needs associated with other sectors.

The defence industry field: procurement and exploitation

The structure of the defence industry field can be analysed in three levels: the strategic level, which determines the product strategy and division of labour in the actor's strategy in interaction with the government and politics field; the organization level, which performs capacity management; and the firm level, which represents units created for the industrial and research activities. In the first level, as stated before, there were clear

[20] AMJAD, Mohammad. *Iran: From Royal Dictatorship to Theocracy*. Greenwood Press, 1989. ISBN-13: 978-0313264412.

strategies for production ranges. In the second level, the "Military Industry Organization (MIO)" managed four distinct industrial capacities or positions, which were different in their life cycle and technology level. These capacities were:

- The first capacity: Value chain of individual and light weapons that incorporated industrial units of mass production of individual and light weapons. This was shaped by technology transfer from Germany.
- The second capacity: The capacity to repair, maintain and support advanced marine and air technologies. These capacities were developed in the last period of the Pahlavi government, mainly as the consequence of foreign mass procurement of advanced facilities, and were overseen by their suppliers. Among the key capacities, there were repair and maintenance of airplanes and helicopters, which had their units established by corporations like Grumman, Lockheed and Bell.
- The third capacity: New facilities production capacity, such as battery making, telecommunication and electronic factories, which produced tools like wireless equipment, night vision equipment, and desert phones.
- The fourth capacity: Transferring production lines. Military Industry Organization had contracts with developed countries for transfer of production lines like helicopters, arsenal industries and some other weapon industries in Isfahan, which had little progress before 1979 and disappeared with the 1979 revolution, and thus had practically no achievement. At the end of the Pahlavi regime, MIO was producing 40 categories of products.

An important characteristic of the field structure in all levels is the dominance of foreign advisors and counsellors. Another characteristic of the industry field in this period was the existence of military organization rules because Military Industry Organization was directly governed by the army and the vast presence of advisors had created coherent socialization mechanism; thus, even people with low academic knowledge would become experienced technicians after a while. Organizational procedures were performed meticulously. Even the communication language in those technical organizations was English and the matters were followed up based on the Gregorian calendar. The unique training system of personnel, cultural interactions with foreign advisors and training courses in foreign countries had all brought cultural and social capital for the industry personnel, which made a difference in that period.

Military bureaucracy would distribute the symbolic capital in accordance with the organization size; in this respect, an unwritten arrangement existed between the personnel of a department and the priority and organizational position. This matter led to an informal competition for increasing personnel and enlarging the organization size.

The anti-tank missile industry, which is the focus of this paper, is among the industries which, in this period, were in the negotiation process for purchasing a licence. The main anti-tank weapon in Iran's army was the BGM-71 TOW missile. Starting from 1971, Iran was among the first importers of this missile from USA. The number of TOW missiles bought by Iran was considerable: total amount of 4760 missiles were bought during 1973-1976 with another 19064 missiles bought during 1976-1979. In the first years of this period, there were some efforts made for preliminary repair and missile calibrations by Iran's Electronic Industries (IEI). In May 1975, the negotiations between Iran and Hughes Corporation for the production of TOW missiles as well as Maverick air-to-ground missiles

did not reach a fruitful end because of the parties' dispute over the pricing system. Hughes asked for 20 million USD for the production of the TOW missile and 25 million USD in the case of the Maverick missile. The 1979 revolution in Iran led to cancellation of all agreements between the parties. After the revolution and between 1985 and 1986, Iran purchased another 2008 TOW missiles from USA through secret dealings known as McFarlane affair (or Iran-Contra affair).[21]

Habitus: Intern Employee

The most important concepts that explain industrial actors' habitus in this period are discipline, learning and following. The industrial actor is an intern employee, who sees his job in the infant defence industry as an opportunity. This realm is attractive, yet obscure, and achieving symbolic and economic capital brings considerable impetus for him to learn operation of industrial systems under the supervision of foreign advisors. In other words, actors in the middle class have chosen a career with economic and social impetus in the military and state industries. This career had a symbolic prestige and high income in the society during that period. The main strategy of the industrial actor in this period was associated with modern industrial norms, learning, conservation and personal discipline. The bureaucratic military environment created a limited space for industrial actors, which gave them no opportunity for creation and agency.

Unlimited procurement of military capacities and products had reached the level of formality before revolution. Hence, there was a habitus formed trying to increase the amount of hardware and expand facilities even if their costs were higher than their advantages and even if they had basically no function in the generation of power for the defence industry.

THE SECOND WAVE: War with Saddam (1980s)

The Position of the Industry Field in Contrast with the Government Field

Due to severe international sanctions, political isolation, and financial constraints, since the Islamic Revolution in 1979, Iran was unable to procure significant quantities of modern military hardware. Thus, Iran was forced to develop its own indigenous defence industry.[22] Also, major changes occurred in the government field as well as other social fields in Iran's society.[23]

The revolution led to a more bureaucratic, authoritative, and mobilizing government, which made it similar to the traditional revolutions and nation-state revolutions. Fundamental reform happened in the administrative structure of Iran and new councils and public institutions were established such as the ministry of construction jihad (Jahad Sazandegi), Islamic Revolutionary Guard Corps (IRGC), and Basij. Hence, a powerful

[21] BUSBY, Robert. *Reagan and the Iran-Contra Affair: The Politics of Presidential Recovery*. Springer, 1999. ISBN: 978-1-349-14726-7.
[22] CZULDA, Robert. Defence industry in Iran–between needs and real capabilities. *Defense & Security Analysis* [online]. 2020, Vol.36, No. 2, pp. 201-217. ISSN 1475-1801 (print) DOI: 10.1080/14751798.2020.1750184. Available from: https://bit.ly/2W7rYxq
[23] FORAN, John. *Fragile Resistance: Social Transformation in Iran from 1500 to the Revolution*. Routledge, 2019. ISBN-10: 0813384788.

bureaucracy was established and expanded.[24] The major trends in this period included nationalization of many industries, enlargement of the government size, outflow of major amount of capital, economic and technological sanctions and 4% population growth.

The revolution led to major changes in the defence and security matters of Iran. Changes in the state and changes in regional and international coalitions of Iran created new internal and external threats for the country. These new threats led to key changes in the military doctrine and military organization in Iran.

Therefore, the defence industry field was in a particular position toward the government and social field. This field should have expanded fast and needed to utilize all its capacity to oppose Saddam. The war atmosphere led to a quick national agreement over the development of the defence industry. For instance, the law of "Credits Exempted from Public Audit" was approved in the parliament in favour of the development of defence industries and there was a waver in the budget law every year which gave the defence industry the opportunity to purchase goods outside tender and bargain as well as other administrative routines, while the government system had also accepted this matter. The openness of the industry field and its connection to other fields due to war led to a production trend of weapons, so in the late 1980s, about 240 national factories as well as 12,000 private workshops were producing weaponries.[25]

The Defence Industry Field: Self-Sufficiency and Learning

In the first level, due to the fluctuating situation of the government, international relations, and everyday pressures of the war, the industry field could not secure clear technological directions; in the second level, two main organization, defence ministry and Sepah ministry, were responsible for the management and development of industrial capacities.

After the revolution, self-sufficiency was the main discourse in the defence industry field. In this period, new opportunities were formed along with the traditional and remaining capacities. What we mean by traditional capacities was MIO, which was modified to "Defence Industry Organization" (DIO) under the supervision of the defence ministry. This part of the field had to increase its production capacity due to major war demand, revolution shock, and exit of foreign advisors. It also had to launch the production in under construction lines and recover repair and maintenance capacities.

The new opportunities in the field were shaped under the influence of the revolutionary institutions, such as the Sepah ministry and revolutionary Guards. The mission of the Sepah ministry was war logistics; it had to create new capacities in the defence industries in order to compensate for shortcomings and sanctions. Two industrial streams were formed under supervision of the Sepah ministry actions. The first stream consisted in the creation of new industrial production units for low-tech and non-complex products,

[24] MIRIMOGHADAM, Mojdeh – GHAZINOORY, Sepehr. An institutional analysis of technological learning in Iran's oil and gas industry: Case study of south Pars gas field development. *Technological Forecasting and Social Change*. 2017, Vol.122, pp. 262-274. ISSN 00401625(print). DOI: 10.1016/j.techfore.2015.12.004. Available from: https://bit.ly/3ncN2hL

[25] CORDESMAN, Anthony H. – HASHIM, Ahmed. *Iran: Dilemmas of Dual Containment (CSIS Middle East Dynamic Net Assessment)*. Westview Press, 1997. ISBN-10: 0813332389.

because production of light and individual weapons and munitions that could meet army needs required capacity building strategies.

The second stream was formed under the influence of "Industrial Self-sufficiency Department" under the Sepah ministry. The collaboration of this department with small groups of young graduates capable of doing research on advanced products resulted in forming a new atmosphere, which was different from that of the DIO and offered special motivation for technological actors to enter new fields. Fields such as missiles, sea, heavy weapons, chemical attacks protection, armoured and anti-armour, electronics and telecommunications were of importance during the war, but the capacity of the DIO was not capable of their realization and accomplishment.

The effort to develop anti-tank missile was the first major game which was performed from 1984. Confronting Saddam's attack and his well-organized armed forces occurred in the time when Iran was deep in the conditions of revolution. Saddam's armed forces and their excellence on the ground became one of the major issues of war after 4 years and Iran's ability for ground war was limited in this period. The number of Iran's war tanks was considerably decreased compared to Iraq's ability in this area (5000 tanks against 750 tanks of Iran).[26]

In the mode of defeating Saddam's attacking tanks, a legend was formed called "Hossein Fahmideh". Hossein Fahmideh was a teenager that jumped underneath a tank with a grenade pin pulled out. The heavy pressure of war had generated an excessive atmosphere toward achievement of anti-tank weapons and the minister of Sepah promised in a television interview a six-month period for achieving anti-tank missiles. A promise that took 10 years to be met.

Habitus: Building the Greenhouse

In this section, we try to elaborate on the characteristics of the new habitus which occupied positions of the field in this period. Thereafter, we address the consequent strategies of this habitus and its achievements.

The industrial actor in this period was an active industrial subject totally different from the 1970s intern. In fact, in this period the habitus of newcomer actors constructed a new context for the industry field.

Feeling a new identity after revolution, high self-confidence after the king's fall, grace seeking originating from beliefs, the hatred toward Saddam, and the atmosphere in society encouraged the actors to believe they can do great and important things. On the other hand, through the Industrial "Self-sufficiency Department", new conditions were established in the government field, which increased the protection, trust and taking the risk of new actions. These factors, along with the scientific and cultural capital brought in by young groups from the university field, created high motivation for the formation of greenhouse spaces in order to develop new technologies. The establishing team of anti-tank industry was a group of young foreign graduates who built a new industrial capacity with this habitus.

[26] CORDESMAN, Anthony H. – WAGNER, Abraham. *The Lessons of Modern War: Volume II: The Iran-Iraq War*. Westview Press, 1990. ISBN-10: 0813309557.

The new habitus led to a combination of top-down and bottom-up approaches that stimulated the creation of a new greenhouse space in the defence industry field, different from the factory space in the field. The capitals existing in the new habitus gave the actors high power and let them approve new projects with high military value for armed forces, at the same time, creating high technical attractiveness for themselves.

The capital and power of industrial actors helped them stabilize themselves with various strategies in the field. Focus on reverse engineering (and not copying) of advanced and achievable systems was the main element of this strategy. The other element of this strategy was (due to lack of industrial infrastructure in the country) moving toward creation of an industrial complex and management of all key sections of the project's value chain, which brought a kind of introspection with itself. The other decision was prototyping the organizational structure of advanced anti-tank missile producers, such as Hughes or MBB. For instance, system engineering department existed in the project's structure from the beginning, while the DIO's context was factory based. These strategies led to understanding of the importance of key learning infrastructures, such as configuration management or testing. The central core gradually understood that there should be a third party to approve the progress of the product. This approach led to the founding of the quality assurance centre and forming of test design knowledge. Without such knowledge, product development is impossible, hence achievement of such knowledge was seriously pursued.

The new habitus formed the field as per the technical situations (and not organizational situations); in other words, technical capital was the priority and people were recognized based on their technical and professional identity. Actors enjoyed freedom in action and bureaucracy was in the minimum extent, thus, anyone working in their military service period in the project had the authority to carry out significant amount of foreign procurement and purchasing. People entering the field were young and possessed cultural and scientific capital; they tried to acquire and achieve technical, social, and symbolic capital.

The trend of growing the technical capital first started with acquiring the knowledge of assembly, disassembly and repair of damaged missiles. Then, key subsets were designed and prototyped and subsequently tested on the factory missile. The first subset that got results was the electronic division of navigation and control. The successful production of these divisions had a major impact on the project progress. It was right after the production of these divisions that the possibility to develop a missile was proved. Before, there were lots of uncertainties and stakeholders did not have much hope. After that, gyroscope, operators, engines, and fuel were produced. Acquiring the know-how for each of these subsets was considered a technical breakthrough, which was experienced for the first time. For instance, gyroscope is a 150g piece containing 200 minor pieces. The form tolerances knowledge for such a subsystem is a valuable know-how which was acquired with a great deal of difficulty. The technology documentation management unit had documented over 250 technologies in the first days of 1992 (which were different in the needs for experts and infrastructure). In 1992, the first missile was tested successfully with domestic subset units. Sepah's successful collaboration with the new industry and purchase of initial batches (despite the faults and sub-standard accuracy) led to the possibility of development and stabilization. Thereafter, the production trend started and the industry produced its 1000th missile in 1996. In this period, self-confidence and

scientific credit of the industry had extensively gown among the academics and armed forces, which gave their work legitimacy as much as procuring the required resources became possible in the hard conditions of the field.

THE THIRD WAVE: Development and Stabilization (1992-2010)

The Position of the Industry Field in Contrast with the Government Field

At the end of the war with Saddam, major changes occurred in the political field, which would alter the situation in the industry field. A new discourse was established, called the construction period. People's expectations of the end of welfare problems, decline of socialist economy, collapse of the Soviet Union and its effect on global policies including the situation of Iran, decline of the national capital, economic sanctions, and some international requirements dictating reformation of the economic structure were some of the factors prompting construction discourse and beginning of economic development based on liberal economics.[27] During the 1990s, the government gave priority to privatization, liberalization, downsizing, and development of exports. Based on these priorities, the first and second development programmes were executed aiming at economic adjustments, but in practice, they could not create a proper balance between the public and private sectors. After the construction discourse, the reformation discourse was formed, focusing on political development.

During these two periods, extensions of international communications and interactions as well as de-tensioning in foreign policies were among the priorities of the government. But the military attack of Iraq on Kuwait as well as the second war in the Persian Gulf were signs of a process leading to tensions in the region. This situation increased Iran's oil incomes. In this period, there was no crisis like that in the 1980s, but the war and the still existing threat of Saddam had their deep impact on the defence industries of Iran and led to investments following a linear direction from the second wave. The increase in income facilitated military procurement. Parallel to selling weaponry, China and Russia started cooperating with Iran for technology transfer purposes and building facilities for production of modern advanced weaponry. Of course, it should be taken into account that the background and context for the production of complex and semi-complex weaponry had become ready in the industry field during the war.

The Defence Industry Field: Retractions and Expansions

After the war, the defence industry field experienced a new wave of transformations. High inflation, the necessity of reducing government costs, economic and political development and de-tensioning of international relations led to considering contractionary policies in the defence industries. Facts and figures reveal that army activities in this period were a minor part of Iran's GDP. This shows a significant difference compared to the military costs during the war. Cordesman & Wagner[28] claim

[27] MILANI, Mohsen. *The Making of Iran's Islamic Revolution: From Monarchy to Islamic Republic*. Routledge, 2018. ISBN-10: 0813384761.
[28] CORDESMAN, Anthony - WAGNER Abraham. *Chapter Seven: Offensive Air Power, Strategic Bombing and Preparation for the Ground Offensive*. CSIS press, 1994. Available from: https://bit.ly/3bgsBNV.

that although it was said that Iran had allocated a major part of its income to improve its military forces, comparing government costs with the costs of weaponry imports and export earnings indicated that Iran constantly allocated a small percentage of its available resources to military costs and weapon imports. For instance, the value of weapons delivered to Iran was 7.3 Billion USD during 1982-1986, 7.8 billion USD during 1987-1990, but decreased to 3.9 billion USD during 1991-1994.

By the end of the war and the decline in the demand, the defence industry field became smaller and thus the industry moved toward a new approach called "dual-using of the defence industries". In the absence of active demand from the war period, the defence industries faced complex uncertainties in the retractions and expansions policies. The indeterminate threats created various small demands for the industry, whose realization were difficult due to the industry focus on the local internal market and ignoring export markets. On the other hand, due to the increase in oil income, purchasing facilities from other countries like Russia augmented in a short period, which consequently decreased the purchasing by internal sources. In fact, for an oil country, imports are always an attractive and serious choice that results in limited attention to domestic development.

By merging the two ministries of defence and Sepah and establishment of the General Staff of the Armed Forces, the need for integration of new and old (or traditional) industrial context was sensed. This merge and changed conditions caused the administrative discipline of the old context to be extended to the new flexible structure, and hence the hierarchical structure was deployed throughout the industry. Gradually, the field became full of organizational positions and jobs for activities such as planning, procurement, trade, salary and income, and recruitment. By merging with DIO, the missile projects were all gathered under the category of "Missile Group" in DIO and became an integrated industrial unit under the supervision of this organization. Thus, the organizational discipline governed the TOW project; as a result, the project was transformed to an organization and project managers became organizational managers. On the other hand, development of general staffs and back offices became a priority and expanded in the new field. Also, supervisory and confidentiality structures experienced considerable growth and became dominant to the field. In the new conditions, the basis of interactions was the transformation of the technical capital to the symbolic capital because acquiring legitimacy for technological projects in restrictive and uncertain conditions was the most important concern in this period.

Merging with DIO and departure from the former flexible environment was accompanied by a rise in laws and regulations, organization growth based on production capacity building and increasing bureaucracy. The industry identity gradually transformed from a design office to a production-based organization whose main human resources were ordinary employees. Becoming production-based organizations caused inertia and increased life cycle costs. In the late 1990s, due to Saddam's debilitation, anti-armour weapons were replaced with other weaponry systems, which led to reduction in industry resources compared to projects with better market and demand.

The new conditions led to new situations and formation of niche capacities. In this condition, the team with no good proposal for the customers became isolated. It meant bottom-up and greenhouse approaches and innovation attitude, which needed to be seriously reinforced. On the other hand, innovation underlying capabilities, such as test and experiment infrastructures, system engineering capabilities, and formal rules, helped

in the formation of formal R&D structures, which ultimately led to new niche opportunities. It means that niche situation formation required a combination of formal and bureaucratic rules (emanating from traditional contexts) and also greenhouse rules. The first and most important niche was electronics, which could bring various ideas for new editions of products.

The industrial actors' capital in this period grew fast. The orientation toward elevating academic education (that had become a movement after the war) promoted their cultural and scientific capital. The symbolic capital grew enormously due to organizational rules, and social capital, such as industry relations and cooperation with customers and universities, increased as well. Physical and economic capital experienced considerable accumulation and the industry had a huge source of hardware and know-how, which gave it a good bargaining power. This power resulted in the separation of the Missile Group from DIO and formation of the Aerospace Industries Organization (AIO).

Habitus: Innovation

The field structure in the previous period was the direct outcome of the new generation actors' strategies. These strategies resulted in capital accumulation and noble position in the field. By the change in situation and occurrence of hysteresis, legitimacy of some thoughts, desires, and structures was endangered. The actors should have reacted to reducing defence concerns, lack of resources, and generalization of formal factory rules to greenhouse by means of different strategies. Naturally, the habitus could not change as fast as the field. The new habitus, whose core was the desire for development and competition in order to achieve higher roles, pursued two strategies in the novel situation: Actors who had a great technical capital (like the above project) tried to bring innovative agenda to the customers and keep their support in continuing their technical path. Industries which did not have a deep technical path and their capabilities were generic, moved toward civil and demilitarized businesses like supplying automotive industries.

System engineering in this period converted to an organizational routine. In other words, work relations and know-how (which were underlying the system engineering capabilities) were embedded in organizational routines, and hence became stabilized. The development of testing and experimentation infrastructures along with system engineering routines provided innovation possibilities. The system engineering habitus is an intricate know-how (for example, understanding a change in a 100*150 matrix), which transforms the operational need to a systematic need in an organizational division of the labour context, and then it integrates required subsystems, such as identification, design, prototyping, and testing. Close interaction with customers expedited niche activities. Those who fought in the field gave fast feedbacks, in fact, the researcher and the fighter were interestingly similar. Agreement with Sepah as the main customer, who allocated more than 80% of demand to itself, was very important. Niche activities could create various ideas for product development, for instance, a digital navigation system and night vision system were embedded in the missile launcher. In the missile itself, there were lots of changes with innovative ideas. The innovation niche promoted production of new versions of missiles such as: Toofan II missile for targeting reactive armours, Toofan III for attack from top, Toofan IV with stronger weaponry head, and Toofan V with laser navigation system, and high accuracy and protection against electronic war. In 2010, Iran

announced the launch of an anti-helicopter type of this missile called "Ghaem", which is a totally different system from that of Toofans.

Technical capabilities in this period grew in a way that the industry was described as follows: "in this factory, ingredients and inputs are entered from one side and anti-armour missile is produced from the other side." Although the developer habitus brought along a considerable technological capability, it gradually encountered the path dependency and introspection. Mass production gradually reduced the flexibility of the industry and led to increased organizational life cycle costs.

From the other side, since this habitus was able to generate considerable capital for technical actors, there were lots of expert resources in the limited space of the industry, that there was no more capacity left. Subsequently, people in this period tried to transform their technical capacity to economic and symbolic capital outside the industry. This matter caused vertical and horizontal migration of qualified human resources and elites (brain drain happened). Some moved to the private sector and some were chosen to launch new industrial units under AIO (horizontal migration). The overflow of human resources led to multiplication of industrial capabilities and new capacities. Through expert resource transfer to private sector, formation of various subsidiary companies in the aerospace collaboration network occurred that their count was almost 400 companies based on interviews. Moreover, relying on their own capital, some of the expert resources started creating new industrial units under the supervision of the defence ministry. Vertical migration is the transfer of expert resources of industry to strategic staff boards and political field, which was developing in this period. "Ya Mahdi" faced departure of expert resources twice, the first time at the end of the second wave when most migrations were horizontal and the second generation of industry got into the steering board. The second time when AIO was established. AIO was a result of Missile Group's independence on DIO. Since the new habitus could not continue remaining in the traditional context of DIO, it gradually separated from this organization and AIO was formed.

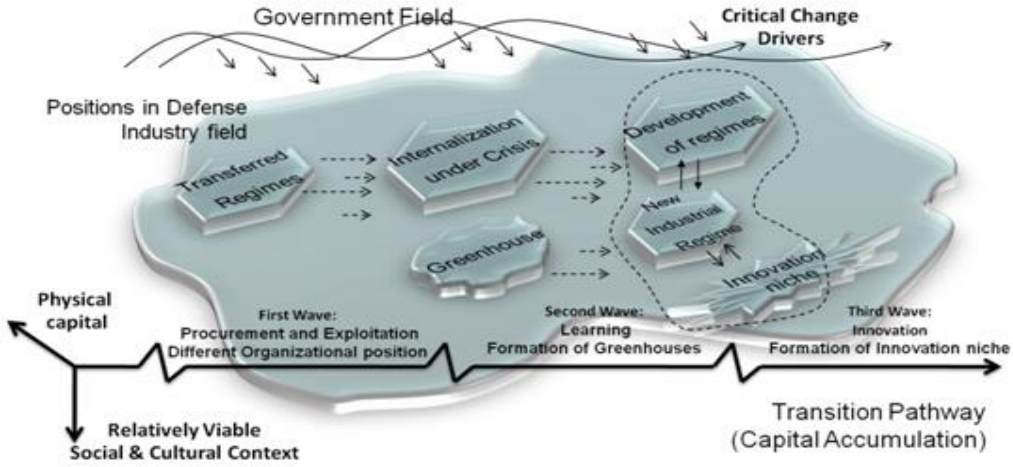
CONCLUSION

In this paper, we tried to explore sociotechnical transformations in the modern defence industry of Iran, with the perspective of historical sociology. In the developing world, two kinds of transitions can be explored: 1) socio-technical system transitions that occur through the interaction of levels of the system, and 2) transitions toward socio-technical system, i.e., transitions which lead to a search for and formation of a multi-level system. In this paper, we explained the second kind of transitions, path formation of regime and niche, through utilization of Bourdieu's theoretical framework. The research demonstrated that the field's position changed in three waves and in the third wave, the positions of niche and regime were formed. In other words, niche and regime, which are the levels of the system in MLP, are specific positions of the field in Bourdieu's view, which are shaped in a historical process.

In its first wave, the defence industry field formed 4 main capabilities, which were in line with the demands of king's traditional army. This happened through a purchase of production lines under the supervision of foreign advisors. These positions, which shaped the logic of industrialism, were different in the depth of technology and business pattern. The second wave came with the 1979 revolution and war. In this period, the industrial

stream of the first wave encountered anarchy, tried to become an independent entity, and even entered new areas. Along with this, new opportunities in the defence industry field, called the "greenhouse" positions, were formed through the entrance of the revolution generation, who had a legitimate identity and support of the government field during the war period. In these new positions, acquiring technical capital based on cultural capital was the main motive of the actors. It means that the production and distribution of symbolic capital were based on technical capital and hence a professional community was grown inside the learning projects. The government field's support was in such a way that it made the natural growth of the technical habitus and its transformation into symbolic capital possible. These positions would, like a dam, gather the released energy and contain technology development motives in themselves. In other words, behind this dam, complex and long-term activities with high uncertainty, like the anti-armour industry, would acquire learning and technical capabilities along a historical path. In this new context, the Iranian society experienced technical birth for the first time and a breakthrough in its historical disbelief in advanced technologies.

Figure 2: Triple Transition Waves in Iran's Defence Industry



Source: GRENFELL, ref. 17

In the third wave, we gradually face a multi-level system, in which regime and niche positions are distinguished. The greenhouse positions reached the production stage and formal rules and organizational rationality were institutionalized in them. Along with them, innovation infrastructures, innovation motives, and demand for innovation lead to the formation of niche positions. Change of threats from regional ones to trans-regional threats with high uncertainty reinforced the need for formation of niche spaces. The positions existing in these three waves in the field are shown in Figure 2 and are compared in Table 1.

Table 1: Comparison of the Triple Wave of Iran's Defence Industry

Waves / Dimensions	First wave, 70s	Second wave 70-92	Third wave 92-2010
Political field	Dependency - regional roles of past regime in contrast to west, technology strategy planning	Persistence against assault with internal resources, lack of technology strategy planning	Development and stabilization of capacities based on definite threat assumptions
Industry field's positions	Hierarchical organization, state assembly, and repair & maintenance factories in MIO	Infant cores, unstable networks in Sepah, Defence, and Jihad ministries	Industrial organization comprised of regime and niche positions
Habitus	Intern employee	Self-sufficiency, attention to tasks, risk and trust, compatibility in war situation	Progress, development and stability
Capital accumulation path	Symbolic capital acquisition based on job functions	Technical capital transformation into symbolic capital	Technical capital and symbolic capital bilateral relation
Major challenge	Haste and focus on turnkey strategy	Lack of balance between capacity growth and needs	Opposition to trans-regional threats, sticking to capacities
Technical capital	Product achievement through final assembly	Dominancy of reverse engineering	Formation of design and system engineering expertise, achieving common platforms
Innovation pattern	Incremental in line with exploitation	Modular in line with quality and cost realization	Architectural in line with future needs realization
Learning pattern	By training and advisory systems	Individual - group in interaction with customer	Organizational and inter-organizational

Source: Authors.

At first glance, it is assumed that the reason for the success of Iran's defence industries is in abundant resources, closed innovation model of this sector, special support, and top-down approaches and that this sector's success originates from distinguished conditions

of this industry from others, like the oil industry or the health sector.[29] However, this paper shows that in the main advances of the defence industry, open innovation has been followed and approaches have been mostly bottom-up. Furthermore, innovation resources and state support in this sector always have been exposed to serious risks and they have not been exceeded those in the petroleum and health industries. In the first wave, the field is hierarchical and environment is tenured. In the second wave, the tenured environment is broken and the bottom-up forces are activated. In the third wave, the field experiences retractions and expansions, formal rules govern the field and regulate and restrict greenhouse spaces and the new regime and niche positions are formed.

This paper tried to present the path-dependence process of emergent new regime and niche positions using Bourdieu's theoretical framework. The main mechanism for the formation and growth of capabilities in these niches was the creation of highly motivated engineering teams, each of which undertook a reverse engineering project aimed at redesigning a complex system. The habitus that developed during this period allowed risk-taking and access to system engineering capabilities. Gradually, the technical capital of these teams grew, and with the support of the political field, it quickly became a symbolic capital. These new identities gradually became actors in the field and institutionalized a kind of engineering culture. A culture that was very different from the first wave.

In the first wave, the pattern of industrialization was based on the import of production lines, spare parts, and assembly. During this period, all the focus was on production and the acquisition of design knowledge was not on the agenda, so it cannot be said that an industrial regime was formed.

Various industries were established before the 1979 revolution, all of which lacked design and research units, but in the case of missiles, an endogenous and spontaneous design capabilities were created, which were constantly engaged in industrial entrepreneurship.[30] The power of system design and engineering allowed the creation of an element of an industrial regime. The ability to design allows the evaluation of technologies and the creation of technological niches. For these developments, we used the concept of transition toward a sociotechnical system. That is, the transition that puts society on the path of search for and creation of sociotechnical systems.

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[30] VAZIRI Javad - GHAZINOORY Sepehr - GHANEI RAD, Mohammad-Amin – FARTOKZADEH, Hamidreza. A three-dimensional understanding of the transition in Iran's defence industry, with an emphasis on the missile industry. *Journal of Management Improvement*. 2015, Vol 28, No.9 pp. 31-54. ISSN 2251-8991 (print). Available from: https://bit.ly/3a1vlOs