The 'Mission to Mars' Case Study, Galbraith's Star Model and other relevant Organization Theory, critically evaluate the reorganization of the Mars Programme that resulted from the introduction of the 'faster, better, cheaper' approach at NASA

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ABSTRACT

In the 1990s, NASA implemented a programme named "Faster, Better, Cheaper," (FBC) which involved essential changes to the way in which the organization used to be established. It was a huge organizational and transformational effort that required delivering dramatic advances in robustness, flexibility, and efficiency. Nevertheless in 1999, the failures of two consecutive Mars Climate Orbiter and Polar Lander missions brought to a stop of the FBC programme. We critically analyze and evaluate NASA's reorganization across of two models of organization theory such as the Diamond and Star, which show that FBC style needed a super-high-tech, a high level of complexity and novelty, and a time-critical pace. In addition, the majority of the missions' failures were also because of the short schedule, limited budget, and a deficient coordination of the processes management particularly in learning.

Keywords: Organization Theory, Technology, Complexity, Novelty, Pace, Strategy.

1. INTRODUCTION

While the goals were excellent, the way that NASA went about applying FBC was surprising to a certain degree. NASA believed that it was far better to manage a number of organizational trials and to progressively learn what things functioned well and what did not. This promising approach to organizational transformation thus relied on managers trying out diverse approaches in order to develop missions. At that point learning from their previous experiences, however, it did not happen what as planned [6]. The purpose of this paper is to critically evaluate the reorganization of the Mars Programme that resulted from the introduction of the 'faster, better, and cheaper' approach at NASA, and to tackle this question and simultaneously contributing to the existing literature of programme management. Some models will be applied to organisation design. I am going to specifically focus on the Diamond and Star models to deconstruct the facts of the mission of Mars case, and the Star model is a good fit for this because it covers all aspect of organization design. The Diamond model will help us to understand the structure of the Mars case mission, and identify the gaps between the current capabilities and what is required to make the mission success. It also will be reviewed to some academic works of literature about the concept of major programmes in order to compare and generate a robust conclusion.

2. LITERATURE REVIEW

The objective of the literature review will be to show readers a clear vision of how to apply the Diamond and Star framework to critically evaluate the reorganisation of the Mars case. Therefore, through this section, we will have the base to analyse the principal question of this paper. According to PMI [9], "a programme is a group of related projects, subprograms, and programme activities managed in a coordinated way to obtain benefits not available from managing them individually".

Others state that major programmes are far more than big projects, they may run budgets over into billions of dollars, and they usually take many years to delivery, from conceptual engineering to completion. They also may have a wide range of stakeholders. Engwall and Jerbrant [2], stated that a multi-project organisational is built by an organisational structure that operates a considerable share of its activities as projects. Others research claim that major programmes' characteristic is their complexity having a transformational effect. Maylor [8] proposed an interesting tool to assess the dynamic project complexity through three dimensions; such as 1) Emergent complexity associated with uncertainty. 2) Sociopolitical complexity related with people, politics, power, stakeholder communities and the project's importance and 3) Structural complexity associated with variety, size, breadth of scope and the interdependence level of task or people.

What does Organization Design? Organization design is the way of configuring an organization through "structure, information decision processes, reward systems, and people" to develop an effective organization in order to achieve its strategy [4]. A strategy consists of some capabilities that an organization must have the purpose of achieving the strategic goals [3].

The Diamond model

The "Diamond Framework" is a model to understand the structure of the programmes, and identify the gaps between the current capabilities and what is required to make the programme

success. The Diamond Model uses four bases to evaluate programmes, to help managers understand the priorities in a more compelling and systematic way: "novelty, technology, complexity and pace."
1. "Novelty" – How deep are the new essential aspects of the assignment?
2. "Technology" – Where does the assignment exist on the level from low-tech to superhigh-tech?
3. "Complexity" – How complicated is the assignment?
4. "Pace" – How critical is the job time?

The purpose of the Figure 1 is to understand the actual structure of the assignment compared with the current capabilities to execute the assignment. The variances between the two will display the gaps that must be filled to make the assignment a right success [1].

Novelty: New Creations

The FBC had a high level of novelty, for example, the Pathfinder mission presented high challenges because of its large solar panel, designed by experts through trial and error, collecting feedback from prototypes. This provided drag by the Martian atmosphere, reducing the spacecraft in an operation known as "aerobraking". However, it was discovered a structural issue with this design on the spacecraft, thus, the aerobraking operation took a year longer than it was planned.

Technology: Technical Difficulty

Superhigh-tech programmes are subject to cost overruns, delays, and risks of product failure. The FBC missions needed Superhigh-tech to achieve its objective. The design of technologies was affected on which people hired for the programme team. The constraints of limited budget and work in new technology could not help much deeply in innovation and new technologies, for example, Pathfinder practically did not develop new technologies, for instance, the navigation software due to they may adapt software from earlier missions.

Complexity: Measuring the Complications

The FBC missions were at least in the system level of complexity, developing complex software and managing a powerful organization, for example, the designing team had to reduce spacecraft size and complexity across micro-technology. With the limited budget, the project at a level could not manage its complexity. They did not provide a suitable development schedule based on mission complexity [7].

Pace: A Sense of Urgency

The FBC missions had a time-critical programmes reducing the average development time from 6 to 3.5 years. That is 40 percent shorter than the non-FBC missions, reducing its development cycles. Nevertheless, the mass of the spacecraft was about 2,700 kilos, whereas the FBC spacecraft was about 290 kilos, which means a reduction of 88 percent, however, it is much more complicated to build a small spacecraft because it needs new technology, and both had almost the similar missions.

The Star Model

The Star Model provides a decision-making framework for organization design [3]. We chose The Star Model (figure 2) mainly for two reasons. Firstly, it is that these elements are controllable by leaders and they can select the type of structure, the processes used for decision making and the people they recruit. And secondly, these are the elements that affect the behavior of people, measuring and rewarding these behaviors it

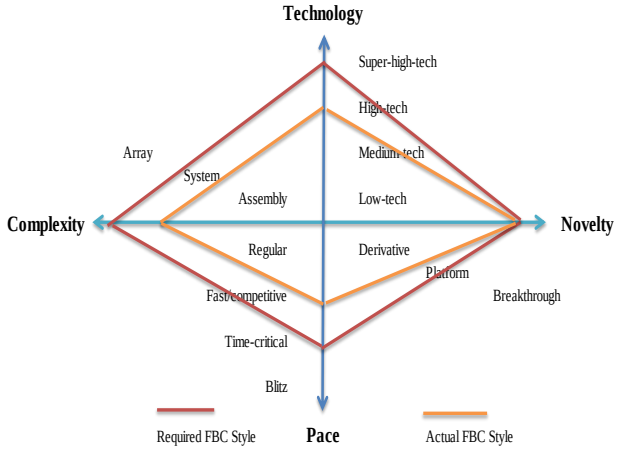

Figure 1. The Diamond Model

is more probable to get cooperative attitudes to collaborative.

According to Galbraith [4] the reason why culture is not included amongst the factors of the Star Model is that managers are not able in a direct mode to control the culture. However, they could change it through the four elements described. Alignment is essential to the Star Model. To support the strategy, each element of the organization should function. The more that the elements (structure, processes, rewards, and people) perform reinforce behaviors and the desired actions, the better capable the organization should be to accomplish its goals.

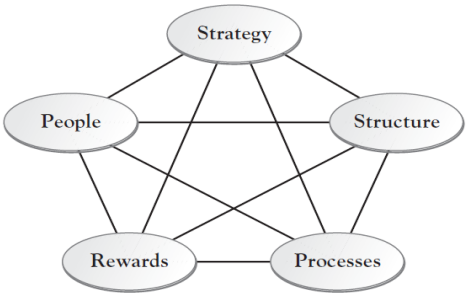

Figure 2. The Star Model [4]

Strategy

Galbraith and Kates [3] mentioned that Strategy is the organization's direction based on its vision and mission in which the firm is going to grow in the short and long-term. The strategy's purpose is to gain competitive advantages in which are created through the organizational capabilities such as skills, technologies, processes that distinguish an organization. Galbraith [4] stated that strategy involves three parts: "what to do, where to play, and how to win". The first strategic part, "what to do", means objectives and goals. According to Maccormack [6], FBC was an action due to increasing development costs and the high-profile disappointments of numerous missions in the 1980s and early 1990s. Its strategy was to move toward less expensive spacecraft, smaller, raising the number of missions that may be funded within a limited budget, while reducing the undesirable impact of failures. With respect to the Mars case, it was decided no more funding for complex, big, as the Viking mission which prospered in the 1970s.

The second strategic part, "where to play", is about the location to be present and the project portfolio to offer. Maccormack [6] said that NASA would launch smaller spacecraft every two years to the planet, utilising information produced in each mission to develop the efficiency of those to follow. In addition, Spear [10] stated that Dan Goldin followed these important directions to facilitate FBC, stopping of putting all "eggs in one basket", developing advanced technology, and Constructing exciting roadmaps and visions for future Missions. The third strategic part, "how to win", is completely about competitive advantage: the formula to compete and get success. Some people who managed FBC projects had exactly the same goals: prevent failure, in the way of controlling schedule and cost. They attempted to do this, nevertheless, in a profoundly different way. They could not rely upon developing management control procedures, which were time-consuming and too expensive. As an alternative, people who run such challenges turned to the dynamics that arose in small, consistent project teams [7].

Structure

The structure of an organization determines the power distribution and the hierarchy of authority. The structure is represented through the organization chart such as the functional organization, business unit or product organization, geographical organization, customer business unit organization, channel organization, hybrid structures organization, and matrix organization. These organizational structures are directly related to the division of labour which it is the level of specialisation of people that execute the work. The more the degree of specialisation, the more level of interdependence is required between units and the greater effectively an organization could execute certain subtasks [4]. Structurally, the Jet Propulsion Laboratory (JPL) used a Matrix Structure that permitted it to share know-how across diverse programmes and projects as required.

Divisions, for example, Guidance and Control, Navigation, Communications, and Propulsion, were sources for expertise and knowledge, and projects were operated through the allocation of specialists, engineers, and managers from the required divisions. Technical staffs reported to both a project manager and division manager, permitting them to leverage their skill across of number of missions over time. However, the Pathfinder team was not a regular practice at JPL, it was totally countercultural. The team was like a band of renegades and rebels, which did not fit the old models and did not have enough hierarchy or rigor [5].

Information and Decision Processes

Galbraith [4] stated that information and decision processes mean the manners in which work is done in organizations. Moreover, Galbraith and Kates [3] point out that process are sequences of linked activities that move information and material up and down through the organization. There are three types of information and decision processes. The first is the informal processes, which are the voluntary behaviors that people spontaneously carry on their work, but they have been changing significantly with the social networks. The second are the business processes such as the new product development, filling an order or the customer relationship. And the third one is the management processes, for example, plan and forecast sales, price setting, project portfolio management, and conflict resolution. Maccormack and Wynn [5] described that it was up to contractors, JPL, and NASA to develop new processes, and new methods of doing business that would permit the faster and better elements. Mars Pathfinder was the first chance to prove that this challenging idea may work. Moreover, a sequence of process changes was applied to strengthen development programs for programme managers, stressing the significance of evaluating, identifying, and documenting critical data for missions. Reviews were made to procedures used for validation and verification, and risk management. Implementation procedures were reviewed to ensure the application of engineering systems.

However, it was not enough coordination between the objectives of the programme and the decision-making on individual projects; in addition, NASA did not ensure that the necessity to learn at the programme was reflected in the planning of each mission [6]. Thus, managers focused just on improving their own programmes, instead of on understanding how those missions may best support programme learning. For instance, the transmitter that cost $4 million would have delivered data on why the Polar Lander 1999 failed, but it was considered too expensive to include it, and without that data, it was more probable that a new mission would not be destined to repeat similar mistakes. Therefore, NASA did not realise that developing an effective programme could have maximized the learning taken from each mission.

Reward Systems

The purpose of a reward system in an organization is motivation. Individuals in an organization have their own personal goals, and these goals need to be aligned with the organization's goals through a reward system. There are four kinds of reward systems that an organization can apply such as bonus, promotions, recognition, and job challenge. First, bonuses have a great influence to motivate behavior; it is an adaptable and flexible form of payment. Bonuses may be utilized to reinforce short-term initiatives and goals. Second, promotions involve the selection and growth of individuals who could advance to upper levels. Some organizations use a systematic examination every three years of an individual's performance previously to recommend him or her for promotion. Third, recognition identifies and rewards the extraordinary individual's performance. For example, an individual might be given a day off for its outstanding performance. Recognition rewards may not cost much money for the organization, but may be quite insignificant for employees. With respect to Mars case, it had single specialists on each subtask; there was no one else to share ideas. Moreover, most employees worked 80 hours per week for months, and if the mission fails, it was not recognized how the team got stress [5]. Fourth, job challenge, organizations that recognize and allow employees to develop other skills will attract and keep more talented individuals. Some people are attracted to a recognized organizations due to they find that the job itself is challenging. Therefore, through the job challenge, organizations could motivate people to perform efficiently. In addition, the FBC teams became completely excited about their job and mentioned they felt good. And this extended to the university, industry, and other NASA Center. However, others FBC teams informed that the good time had gone away because of their resources were cut extremely [10]. Certainly, the design of reward systems is driven by the organization's strategy.

People

People in the organization design focuses on selecting the mind-sets and skill sets and that needs to be aligned with the organization's strategy through different practices such as recruiting, training, selection, promotions and rotations. These

are Human Resource practices, and also the accountability of the business managers. There are three practices for searching and training of talent. The first is "hire hard and manage easy" that means if you work hard on hiring and selecting to get the right person, then you will probably have people in performing efficiently their work. It is good strategy involving students about how it is the real life working in missions, encouraging them to work in NASA [10]. Therefore, hiring, motivating and retaining talent people, producing interest in NASA must begin at the schools. Nevertheless, it was not so real, for example, the Pathfinder mission had a total of 330 people, compared to 2000 people for Viking mission. There was only one specialist for every task [5].

The second one is "hire for fit, train for skills", which means that the first priority in recruiting and selecting people is the fit with the organization's culture. About the Mars case people got overconfident; maybe the early successes attracted individuals who did not appropriately understand FBC strategy; or perhaps NASA went too far, over modifying an initial success level that was possibly too high [11]. The third practice is rotational assignments, which is possibly the tougher one to implement. This practice is essential to developing individuals who will have a complete perspective of an organization that has several dimensions. Many people worked numerous projects because of the classic matrix structure. For instance, they had used many common systems between two missions [5].

3. RESULTS AND CONCLUSION

As we reviewed in the last section, we went through the Mars case analyzing and evaluating critically its reorganization across the Diamond and Star models, therefore, we may deduce that from the analysis of the four aspects of the Diamond model, we developed the framework as the figure 1 showed that the required FBC style need a super-high-tech, a high level of complexity and novelty, and a time-critical pace, however, the actual FBC style showed some gaps amongst all the aspects, except the Novelty. With respect to the Start model, the five elements were critically evaluated of the reorganization of the Mars case mission. Although the earlier missions succeeded because they had more flexibility in their budgets and time, the FBC strategy applied was too challenging to implement it in the real context that NASA was having. This was noted in the later missions because most of them failed because of the limited budget, short schedule, and deficient coordination of the processes management especially in learning.

4. REFERENCES

[1] Aaron, S. & Dvir, D. (2007). "**Reinventing Project Management - The Diamond Approach to Successful Growth and Innovation**. Harvard Business School Press Book Summary.

[2] Engwall, M. & Jerbrant, A. (2003). "**The resource allocation syndrome: the prime challenge of multi-project management?**". International Journal of Project Management.

[3] Galbraith, J. & Kates, A. (2008). "**Designing Your Organization: Using the STAR Model to Solve 5 Critical Design Challenges**". Hoboken, NJ, USA: Jossey-Bass, 2008.

[4] Galbraith, J. (2014). "**Designing Organizations - Strategy, Structure, and Process ate Business Unit and Enterprise Levels**". Third edition. Published by Jossey-Bass.

[5] Maccormack, A. & Wynn, J. (2003). "**Mission to Mars (A)**". Harvard Business School Publishing, Boston, MA 02163, or go lo hltp://www.hbsp.harvard.edu.

[6] Maccormack, A. (2004). "**Mission to Mars - It Really Is Rocket Science**". Harvard Business School.

[7] McCurdy, H. (2001). "**Faster, Better, Cheaper: Low-Cost Innovation in the U.S. Space Program**". Baltimore: The Johns Hopkins University Press, 2001.

[8] Maylor, H. Turner, N. and Murray-Webster, R.(2013) **How Hard Can It Be? Actively Managing Complexity in Technology Projects.** Industrial Research Institute.

[9] PMI(2013)."**A guide to the project management body of knowledge**". Pennsylvania: Project Management Institute.

[10] Spear, T. (2000). "**Nasa FBC task final report. FBC Task Master**. [Online], Available. Accessed 31/10/16. https://nasasearch.nasa.gov.

[11] Ward, D. (2010). "**Faster, Better, Cheaper Revisited**". Program Management Lessons from NASA. Lt. Col. Dan Ward, USAF. Defense AT&L: March-April 2010.