



**PART CANCELLATION PROCESS ANALYSIS
IN ROYAL SAUDI AIR FORCE**

THESIS

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AFIT-ENS-MS-20-S-035

**DEPARTMENT OF THE AIR FORCE
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THESIS

Presented to the Faculty

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Degree of Master of Science in Logistics and Supply Chain Management

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Royal Saudi Air Force (RSAF)

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Royal Saudi Air Force (RSAF)

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Abstract

The issue that this study will address is the increase of part cancellation numbers in the Royal Saudi Air Force. To discuss this problem, the purpose of this study will be to explore the leading causes for part cancellation increases in RSAF and find possible ways to eliminate them. Data were collected through an interview with F-15S maintenance squadron commander and survey distributed to RSAF members, including managers and technicians. The outcomes of this study indicate that there is a lack of training, communication, planning, and supervision. The results will help RSAF members to avoid part cancellation increases. Further research is needed to find other factors that might affect the maintenance culture towards asset reliability and maintainability in RSAF.

To my parents

To my wife

To my country

Acknowledgments

I would like to extend my sincere appreciation to my faculty advisor, Dr. William Cunningham, for his guidance that he has given me over the past two years. I would also like to thank Dr. EL Shaw, for his great support throughout this thesis.

Sami S. Aljuaid

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PART CANCELLATION PROCESS ANALYSIS IN ROYAL SAUDI AIR FORCE

I. Introduction

1.1 Background

Nowadays, technology is an essential factor in social development. A lot of inventions had been discovered in the recent passage of time. Aviation industries try their best to be compatible with the market's needs and requirements. Furthermore, the goal of great aviation companies was to keep maintainability and sustainability of aircraft. One of their most important aims is to provide the required spare parts for their customer at the right time and right place. Some parts became obsolete items because the vendor no longer exists. The customer will have a challenge to find a local vendor who can manufacture a specific piece with the required quality and specifications. Failure to acquire the part could lead to grounding the aircraft, which means the aircraft could not meet mission requirements.

In Royal Saudi Air Force, aircraft maintenance and availability of spare parts are the main factors that keep RSAF aircraft flying. This thesis presents the part cancellation rates, the most important causes, and suggests ways to minimize the part cancellation numbers in RSAF.

1.2 Motivation

In this research, the motivation is to have a good understanding of the current situation for RSAF regarding asset-reliability, improve the maintenance culture, and to minimize the high percentage of part cancellation numbers. This research is concerned with part

cancellation, whether or not it is an issue RSAF needs to be concerned with, and to find ways to minimize the time and effort wasted on part cancellation issues .The study will help to have a well-organized plan to tackle the new problems that could affect asset reliability and capability.

1.3 Problem Statement

In order to fulfill mission requirements, RSAF should have excellent aircraft maintainability. The supply Squadron is responsible for aircraft parts delivery in the right place and at the right time. The wrong, duplicate and canceled part orders negatively impact supply delivery efficiency, therefore mission requirements will not be fulfilled. In the recent years part cancellation in the logistic wing became an escalated issue to RSAF headquarter. Once the order is placed, it happens that the order is canceled for many reasons. An increase in part cancellation numbers might affect the status of aircraft, therefore operational requirements.

1.5 Methodology

In this thesis, a case study will be conducted to give a clear picture of the current status of RSAF regarding part cancellation numbers. Data will be collected through formal requests to RSAF directorate of aircraft and maintenance, interviews with maintenance squadron commander and survey questionnaires that were distributed to supply and maintenance personals.

1.6 Assumptions and Limitations

This research will deal with the available recourses from RSAF headquarter and will not include a financial perspective. This research will be limited to Royal Saudi Air force assets.

1.7 Research Objectives and Questions

The research objective is to study the current situation of the RSAF part cancellation process, and to find possible ways to minimize the massive increase in part cancellation in RSAF.

The research questions are:

1. What are the factors that are causing part cancelations in RSAF?
2. What are the most important factors among them?
3. How to reduce part cancelation?

1.8 Chapter Summary

This chapter provided an overview of the research objective, and methodology that will be used to obtain the required data. This research aims to assess the current status of RSAF part cancelation increases, and find the most critical factors that contribute to this issue. The results will assist with improving the RSAF supply chain efficiency and raise the level of aircraft readiness and maintainability.

II. Literature Review

2.1 Chapter Overview

This chapter provides an overview of the importance of supply chain management and maintenance culture. Then, it explains the effect of the human factor in an organization. Finally, it discusses RSAF policies, manuals, and similar research was done on RSAF C-130.

2.2 Supply Chain

Jain (2010) stated that it is not surprising that there has been much debate as to a specific supply chain management definition. Ganeshan and Harrison (1995) have defined supply chain management as a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers. Lee & Corey (1995) stated that SCM consists of the integration activities taking place among a network of facilities that procure raw material, transform them into intermediate goods and then final products, & deliver products to customers through a distribution system. Christopher (1998) defined the supply chain as the network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate customer. Supply chain management is the " strategic and systematic coordination of the traditional business functions and the tactics across these business functions within a particular firm and across businesses within a supply chain, for the purposes of improving the long-term performance of the individual companies and the

supply chain as a whole" (Mentzer et al. 2001). So, supply chain management is performed in every firm in different degrees. A strong supply chain would reduce unnecessary costs and improve asset reliability for any organization (Jain et al., 2010, p. 12). Furthermore, transports of goods and delivery of parts in the right time and right place play a significant role in supply chain management.

2.3 Maintenance Culture

Matsumoto has defined culture as “the set of attitudes, values, beliefs, and behaviors shared by a group of people, but different for each individual, communicated from one generation to the next” (Matsumoto, 1996). Each organization would develop their own shared culture with a passage of time. An organization's culture sometimes tends to oppose new changes. “Any change that conflicts with an organization's culture will be extremely difficult to introduce. However, new values and beliefs can be developed through good company policy, operational practices, and a management style that can become a culture in the future” (Tennant et al., 2002).

In the Royal Australian Navy (RAN) Van Oosterhout & Bil (2017) used a survey methodology to assess RAN culture towards assets. The questions were asked in a way to draw a top view picture of RAN staff behavior asset reliabilities, and to determine if the environment is adaptable to accept changes. The average service was 7.7 years. The largest group scored (36%) served from 0-5 years , the 5-10 years group scored the second-highest, those who stayed at minimum 15 years scored (12%). It was evident from the results a lot of planned maintenance was not carried out for several reasons. The average length of service was 4.75 years for those who felt too busy to carry out planned maintenance; hence the more time a sailor has served the more he gets too busy to carry out planned

maintenance. The reason for that is more tasks will be added to the sailor to perform, such as operator and supervisor for junior sailors. With the increment in the operational requirement, RAN is still suffering from a shortage of manpower to perform the daily tasks rather than conducting the planned maintenance. Nevertheless, some planned maintenance could be delayed due to a lot of operational activities in accordance with technical orders books. Exactly, the same is done in aviation, but this delay for planned maintenance should be approved by engineers to make sure it is not detrimental to the safety of the fleet. The junior sailors rarely had the opportunity or the required training to conduct trend analysis (training and safety lack of experiences). The asset or system operates outside its optimal operating environment. Exceeding limits could sometimes be harmful to the equipment if done repeatedly in a short period. Still, there are also military exercise requirements such as a hostile situation, man over board, or casualty evacuation (training purposes). Most of the respondents considered themselves to be a combination of both maintainer and operator. The more they serve, the more they gain additional knowledge in operator requirements. Unsurprisingly, the respondents who considered themselves to be a monitor did not serve more than two years. Increased use of simulation could be useful to raise awareness of poor culture practice, and to bring down the total cost of maintaining assets and increase reliability. Use of automatic data is very helpful because it would notify the technician before the operational limit has been exceeded. Military requirements are an acceptable reason to exceed system and operating limits where sometimes these could not be avoided, for example, actual man overboard. It is preferable to avoid exceedances during normal exercises to maintain asset reliability. Most fleet employees staff considered themselves to be proactive rather than reactive, which is a good indication. Being proactive, you can predict where and when the failure or malfunction will occur then act accordingly.

Using a simulator would be very helpful because the trainee would have a chance to repeat the exercise or replay his performance with his instructor for evaluation purposes. The impact of poor or missed maintenance can be reviewed for training purposes. RAN personnel should have more training to conduct trend analysis, such as fuel consumption and vibrations, to prevent failures or malfunction (van Oosterhout & Bil, 2017).

Maintenance culture in RSAF should be assessed. Many maintenance squadrons suffer from a shortage in manpower. Maintenance is a very important and valuable area to support in order to maintain good asset reliability.

2.4 Manpower Shortage

It is necessary that for every organization, there should be sufficient manpower to perform the assigned tasks effectively. Van Oosterhout & Bil (2017) reviewed that in 2014, the US Navy announced plans to add more maintenance personnel to ship crews and perform more maintenance activities on-board ships as they are deployed in order to reduce the costs and time needed at the shipyard upon their return (Osborne, 2014). Adding maintenance personnel to ship crews helps reverse the impacts of a decade-old plan called optimal manning, which sought to reduce crew sizes with a sharper warfighting focus and improved on-board technology. After going through a period of downsizing the size of the crews and to make them just about warfighting, the process went a bit too far, and the idea is to man ships with enough personnel so that sailors can learn how to maintain their own ship. Placing more maintenance personnel aboard ships helps the US Navy by better sustaining ships and further refining technical skills and training for sailors who are engineers and mechanics. In addition, performing maintenance work at sea greatly reduces the shipyard maintenance costs (van Oosterhout & Bil, 2017, p. 6).

Reduced manpower in the Royal Australian Navy (RAN) has resulted in the focus of technical sailors shifting from maintaining naval assets to operating them. This reduction in manpower, when coupled with a largely unchanged maintenance philosophy, is affecting the maintenance culture across the feet and has impacted asset reliability and availability (van Oosterhout & Bil, 2017).

“The reduction in numbers has resulted in a practice called minimum manning which requires technical staff to amalgamate roles and become both system operators and maintainers. The line between operator and maintainer has become blurred. This has resulted in reduced technical integrity as sailors spend greater time achieving operator qualifications, participating in compulsory ship duties and reduced time in conducting planned maintenance activities” (MaECaC Division, 2011).

2.5 Human Factor

Van Oosterhout & Bil (2017) explained that human factor plays an essential role in maintenance organization. There are two key objectives to Human Factors when it is applied to man-machine systems (Chapanis, 1996):

1. Human Factors affecting operators and users are used to improve work environments; aesthetic appearance; ease of use; and reducing fatigue, boredom and monotony.
2. Human Factors affecting reliability and maintainability are used to improve reliability and maintainability, while reducing manpower requirements and training.

Furthermore, Occupational stresses on board RAN ships are likely to a certain extent and will generally fall into four categories (Dhillon, 2009). These are:

1. Workload-related Stressors are either work under-load or work overload. Under-load is typically those jobs of a repetitive or boring nature. Work overload will usually exceed the skills and training of the maintainer.
2. Occupational change-related stressors involve cognitive and behavioral factors in maintainers.
3. Occupational frustration-related stressors are derived from poor communication, poor career development or role ambiguity.
4. Miscellaneous stressors are environmental type factors such as lighting, temperature and noise.

Human functional performance is related to the level of stress, as shown in Fig. 1. While a moderate level of stress shows an increase in performance, the definition of moderate is subjective and will vary between individuals. Research has shown that workload is negatively related to job satisfaction and positively related to depression, anxiety and irritation, all stress precursors (Bridger et al., 2007). It is likely that maintenance will not be carried out or the quality of maintenance will suffer should maintainers become increasingly stressed (van Oosterhout & Bil, 2017, p. 8).

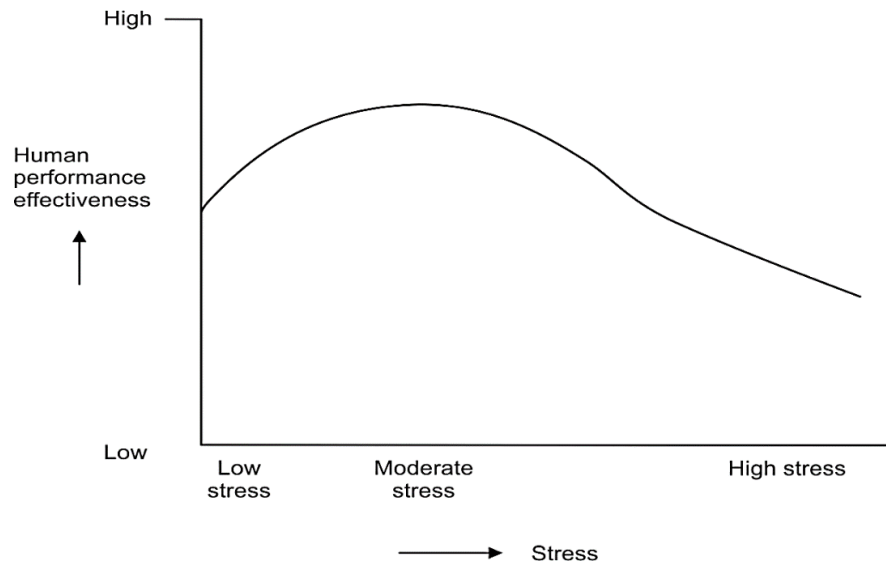


Figure 1. Human performance(van Oosterhout & Bil, 2017)

RSAF maintenance squadrons are experiencing a shortage in manpower due to many reasons such as an increase of resigns, retirements, deployments, exercises, and a high rate of operational requirements.

2.6 Goldesp

The Royal Saudi Air Force uses Goldesp as a management information system that controls maintenance actions, material management processes, parts orders, and part cancellations. *GOLDesp* is “Miro’s combat-proven, fully deployable software specifically designed for aftermarket logistics support, maintenance, supply and repair operations and PBL program management. The *GOLDesp* suite merges global asset visibility with complete product life-cycle management into a COTS application that can support a customer’s total maintenance and supply needs across the enterprise.

Key functions supported by *GOLDesp* include:

- Data distribution and deployment management (for operating in disconnected environments)
- Product life cycle management including full maintenance planning and work recordings
- End-item configuration management and maintenance
- Materials forecasting and replenishment
- Repair management and recording
- Inventory and material management
- Asset tracking for Government Property and company-owned property
- MILS Requisitioning capability that allows a contractor or a US Foreign Military Sales (FMS) customer to requisition directly against DoD sources of Supply
- MILS capability to permit a contractor to be an Inventory Control Point (ICP), to receive DoD MILSTRIP-formatted supply requisitions directly from the battlefield
- Failure and trend analysis for improving engineering and preventative maintenance, and Online Analytical Processing (OLAP) tools for better decision support
- *GOLDesp* Business Intelligence tools, dashboards and exception reporting and business process monitoring for high level executive command and control”(*GOLDesp Product Overview*, 2013). As illustrated in Figure 2.

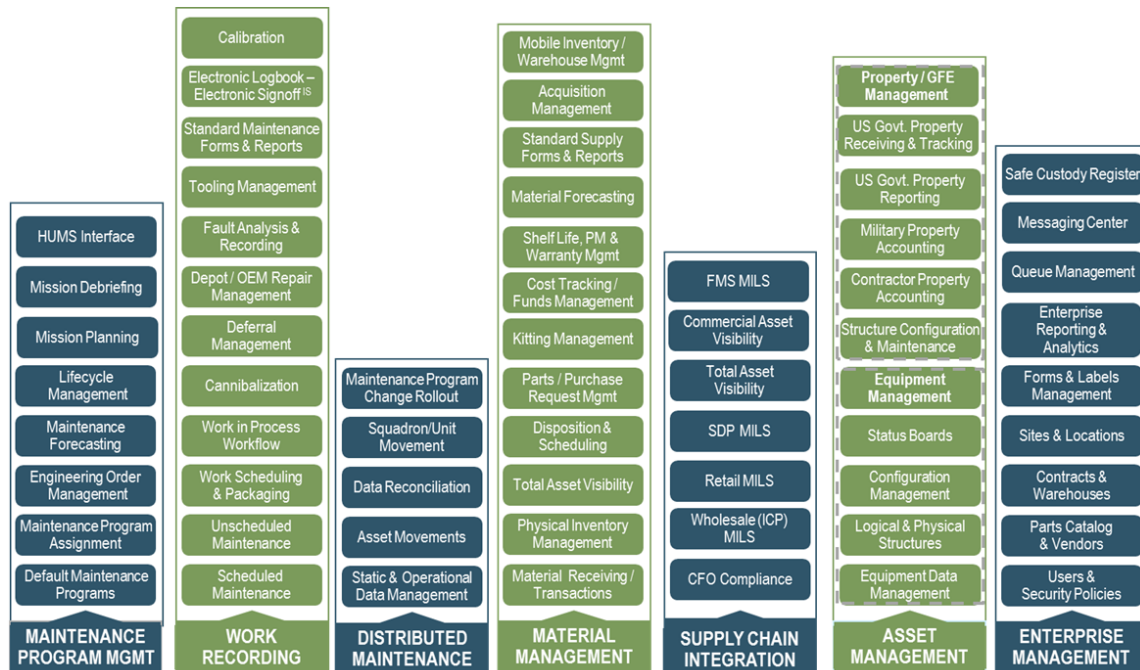


Figure 2. functional footprint (Miro,2013)

Why should the Royal Saudi Air Force (RSAF) use Goldesp to handle logistics activities?

“Miro Technologies is the leading, best-of-breed, military grade MRO software provider for operational and aftermarket support of complex assets in the global Defense market -- Air, Sea, Land and Space. Miro is currently the largest supplier to the international defense sector. Miro’s COTS products have been successfully implemented as a tri-service logistics management solution by military organizations around the world. Miro is the only MRO IT supplier that is primarily dedicated to the unique needs of the Aerospace & Defense (A&D) industry. The Company is a market leader in the U.S. A&D market where Contractor Logistics Support (CLS) and PBL programs are managed by

prime contractors and original equipment manufacturers (OEMs) Our technology solutions have helped military logistics organizations to achieve outstanding results:

- **Asset availability** – Miro clients consistently report mission capable rates exceeding 85%
- **Cost reductions** – USAF C-17 fleet has reduced contract dollar per flight hour by 29%
- **Inventory reductions** – GOLDesp customers report 8 – 20% reductions in high value component inventory levels
- **Documented cost savings** – USAF C-17 fleet has recognized cost savings of \$1 billion to date, with another \$12 billion in savings “guaranteed by the OEM” over 30-year program
- **Widely Adopted** - 17 of 21 USAF Contractor Supported Weapon Systems programs rely on GOLDesp ”(*GOLDesp Product Overview, 2013*)

Gold is a beneficial tool to manage the fleet logistical requirements. However, every technician in supply or maintenance should be aware of a quite well knowledge area to be able to perform the assigned tasks properly.

2.7 Cannibalization (CAN)

Can usually occur when the part is not available at the base. Unfortunately, sometimes can is misused, which would exceed the allowed limits, and subsequently, the aircraft will be impounded, and no more can is authorized. Can is defined by RSAF instruction manual (2017) as is the authorized removal of an assembly, sub-assembly, or component part from an end-item (aircraft, aircraft engine, support equipment, etc.) for installation on another

end item, with an obligation to return or replace the removed assembly, sub-assembly, or component part. Cannibalization is a maintenance action to relieve a spare shortage so that operational and maintenance tasking can be met. Can rates should be monitored by the maintenance squadron commander. The requirements for cannibalization is definitive indication of support problem. If the cannibalization rate/number is high and the NMCS (not mission capable supply) rate is high, then it follows that maintenance may unnecessarily be providing its own parts. This situation should be questioned. In addition:

- a. A high cannibalization rate/number degrades spare parts availability.
- b. By removing the impact of support problem with a cannibalization action, the reason that the cannibalization took place must be investigated.
- c. Any items that are damaged during the cannibalization process will further degrade spare parts availability.
- d. Cannibalization reasons and the related supply stock level issues must be immediately investigated and corrected.
- e. Special attention must be given to items that are repeatedly cannibalized
- f. A continuous effort in the quality improvement process (for suppliers or repairs) must be exerted (RSAF66, 2017).

The researcher believes that the ease of the can process could lead the maintenance personnel to take the step of cannibalization instead of having a burden of waiting for the spare part delivery time, especially if the delivery time is too long. Then, he would go and cancel the part order; he just placed. This would raise the part cancellation number in the specific flight.

2.8 Part Cancellation in RSAF

The first study on the Royal Saudi air force regarding part cancellation was conducted in 2019 by a former researcher at AFIT, Major Aziz Alajmi, and supervised by Dr. Cuningham. Furthermore, the research was acknowledged by the Royal Saudi air force director of supply directorate, and he urges and motivates more studies to tackle the part cancellation issue. However, the study was narrowed down to the C-130 fleet only. Alajmi (2019) stated that the main reasons for part cancellation as follows:

Duplicate orders & received on another document number: a total of 43% of orders canceled (182 out of 423 orders) due to duplicated orders and part received on another document number , this issue while investigating was found to be associated with other orders of following nature : common used parts, parts for aircraft system or sub-system use more than a single piece of the same part or parts with substitute. Incomplete order: total of 36 % orders canceled (155 out of 425 orders) due to incomplete orders information and details, deeper research shows the occurrence of such cancellation was due to : user input errors or parts ordered first time without attaching part specification and technical order reference. Found alternative part number: total of 16% orders canceled (70 out of 425 orders) because an alternative part number was located likely to happen due to one of the following Goldesp is not updated with all alternatives, the technician is unaware of different part numbers or outdated or limited recourses to search for alternatives. (Alajmi, 2019).

These were the main reasons for part cancellation in C-130 squadron. The researcher agrees with all reasons mentioned above based on his field experience, and the researcher believes that many squadrons have similar reasons or the same reasons for part cancellation.

Alajmi (2019) also stated that “the research analyzed and identified the gaps of RSAF C-130 material management, including main member of the supply chain. The finding of this study suggests ways for RSAF managers and individuals of C-130 maintenance and supply to evaluate their technician’s knowledge and improve their awareness, which will improve overall part cancellation rate” (Alajmi,2019). The study was valuable, and after that, a question was raised whether part cancellation is an issue only the C-130 fleet should be concerned about, or it is an issue that had been escalated to the entire fleets of Royal Saudi Air Force. This study motivated the researcher to explore the obstacles and factors that cause part cancellation to increase and find possible ways to improve the maintenance culture towards assets maintainability.

All the reasons Alajmi stated were human error input. This research will explore that if other factors contribute to part cancelation increases in RSAF. Then, it suggests ways to prevent part cancelation rises.

2.9 Chapter Summary

Concluding this chapter, it reviewed that the supply chain management importance and maintenance culture. Then, it showed the effect of the human factor in an organization. Secondly, it discussed specific RSAF policies, manuals, and similar research is done on RSAF C-130.

III. Methodology

3.1 Chapter Overview

This chapter illustrates the data collection method and the methodology used for analyzing these data. This chapter presents a methodology for determining part cancellation exitances in RSAF maintenance squadrons and the main factors that contribute to escalating the part cancellation numbers.

3.2 Data Collection

The first step in the analysis was part cancellation process in RSAF C-130 maintenance squadron done by a former researcher at AFIT, Major Aziz Alajmi. The part cancellation process was analyzed as to the order was initiated and how many scenarios could the technician follow to cancel an order. C-130 squadron had several reasons for part cancellation.

This researcher will conduct a case study on the available data on the RSAF database, then evaluate the current status of the maintenance squadrons regarding part cancellation, compare the results, and find possible solutions that could reduce the rise in part cancellation numbers. This will contribute to improving the maintenance culture towards assets.

The researcher will collect the data from February through June 2020. Data will be collected from different maintenance squadron in RSAF, then group all the required data using Microsoft Excel software. The results will be presented in tables and charts to see that part cancellation is an issue RSAF should care about, and to have a better understanding of the current status of RSAF maintenance squadrons regarding part cancellation issues as well as reasons affecting part cancellation increasing. The researcher

will use the results of surveys, interviews, and available data at RSAF database to answer the research question for this research.

3.3 Survey

The researcher developed surveys to gather information for this thesis. All feedback results were returned back to the researcher and, saved in Microsoft excel. The study populations were officers and airmen from different maintenance squadrons. The surveys were developed to have a good idea about the following aspects:

1. Maintenance culture and perceptions.
2. Causes of part cancellation.
3. Participant profile (language, experience, and knowledge).
4. Planned maintenance.
5. Time of part cancellation occurrences.
6. Heavy operational requirements effect on part cancellation.
7. Manpower shortage.

Supervisors and Officers Feedback

This survey targets the Supervisors and Officers levels of different maintenance squadrons. Their experiences and observations would help to find ways to reduce the high percentage in part cancellation numbers.

These questions were provided in an email request. The results will be shown in Chapter IV.

The questions will be:

- 1- Does the part cancellation increase in unscheduled maintenance activity?
- 2- What are the main reasons causing the part cancellation?
- 3- Do you think the maintenance staff's language level and technical knowledge are directly proportional to the part cancellation increase?
- 4- How do you know that the part cancellation numbers are escalating?
- 5- Does the analysis and production section notify the supervisors when the numbers of part cancellation are high?

Technicians Feedback

This survey will be distributed to the enlisted technician who might have interacted with part cancellation on regular bases. Sharing their perspectives will be valuable to support this research.

The questions will be:

- 1- Do you think your shop has an insufficient workforce?
- 2- If you canceled part, what is the reason you type in to cancel the previous order?
- 3- Have you ever canceled an order because it was a wrong order?
- 4- When is the maximum number of part cancellation observed?
- 5- Do you know if part cancellation in your specific shop has increased?

3.4 Interview

The researcher will interview the F-15 S maintenance squadron commander. The researcher will collect data by interview because:

- 1- The researcher cannot observe the participants directly.
- 2- Participants will be able to provide historical data.
- 3- It allows the researcher to find answers to his questions.
- 4- A useful way for feedback.

The researcher will use the following steps to enhance a productive interview:

- 1- Ask permission from the RSAF headquarter.
- 2- Send the questions to the interviewee.
- 3- Set the appropriate time for the interviewee.
- 4- Set the time, place, and communication devices will be used for the interview.
- 5- Send a reminder before the interview.

The questions will be:

- 1- What are the reasons that are causing part cancellation?
- 2- What are the most significant among these factors?
- 3- How to eliminate them?
- 4- Do you think it is possible to link the technician's user account with a mandatory test on the part cancellation process?

3.5 Chapter Summary

In summary, this chapter outlined the methodology used for writing this report. The researcher obtained the data through several approaches: survey, interview, and RSAF accessible data.

IV. Analysis and Results

4.1 Chapter Overview

This chapter would help to develop a better understanding of the problem and, could help RSAF to determine the weak areas in maintenance squadrons. This chapter will include an analysis of the collected data. Obtained data will help to answer the research questions. The first survey was answered by 81 technicians out of 123 (a 66% response rate) from different maintenance squadrons. The second survey was answered by 41 out of 48 supervisors and officers (an 85% response rate).

4.2 Results

The results obtained for this research are divided as below:

Current Available Data

The researcher requested the data through a proper chain of command of the Royal Saudi Air Force. The researcher eliminated incomplete and unnecessary data. Data were grouped using Microsoft excel. The data shows the current situation of the Royal Saudi Air force regarding the part cancellation issue.

Part Cancellation Numbers in Several Maintenance Squadrons

The maintenance squadrons which the researcher is concerned about are F-15 C-D, F-15 S, Helicopter bell 412 -212, and C-130 Hercules. The part cancellation numbers for each squadron as shown in the table below

Table 1. PC numbers in RSAF

SQN	Time	Part cancellation no
F-15 C-D	1/1/2019 till 1/1/2020	500
F-15 S	1/1/2019 till 1/1/2020	590
C-130	1/1/2019 till 1/1/2020	464
Helicopter 212-412	1/1/2019 till 1/1/2020	230

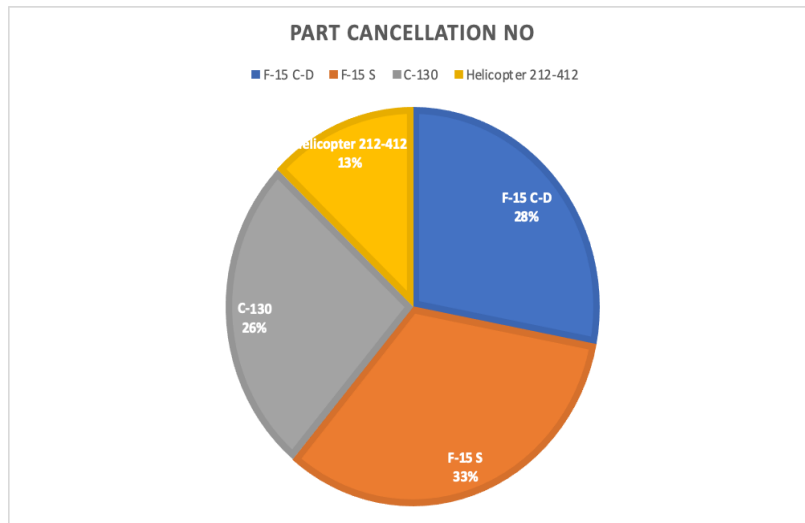


Figure 3.PC Numbers pie chart

By looking at the numbers in the table and the figure it is clearly understood that part cancellation numbers are high in several maintenance squadrons in the Royal Saudi Air Force. However, as shown in the figure 3 F-15 S scored the highest percentage with 33%

of the total number of part cancellations in Royal Saudi Air Force, with helicopter 212-412 as the lowest percentage, with 13% of the total part cancellation numbers.

Reasons for Part Cancellation

Part cancellation occurs for several reasons. However, the reasons found in Goldesp were not sorted and categorized correctly. Many shops, after canceling the part type in the Goldesp part, canceled for other reasons, which makes it difficult for the managers and supervisors to track the valid reasons that cause the part cancellation number to increase. Nevertheless, many shops write the part is fixed, then cancel an order where in fact, the part was canned from another aircraft. The researcher gathered the data, sorted them in Microsoft Excel, and eliminated incomplete data, and categorized the data to explore what are the main categories for the reasons for part cancellation.

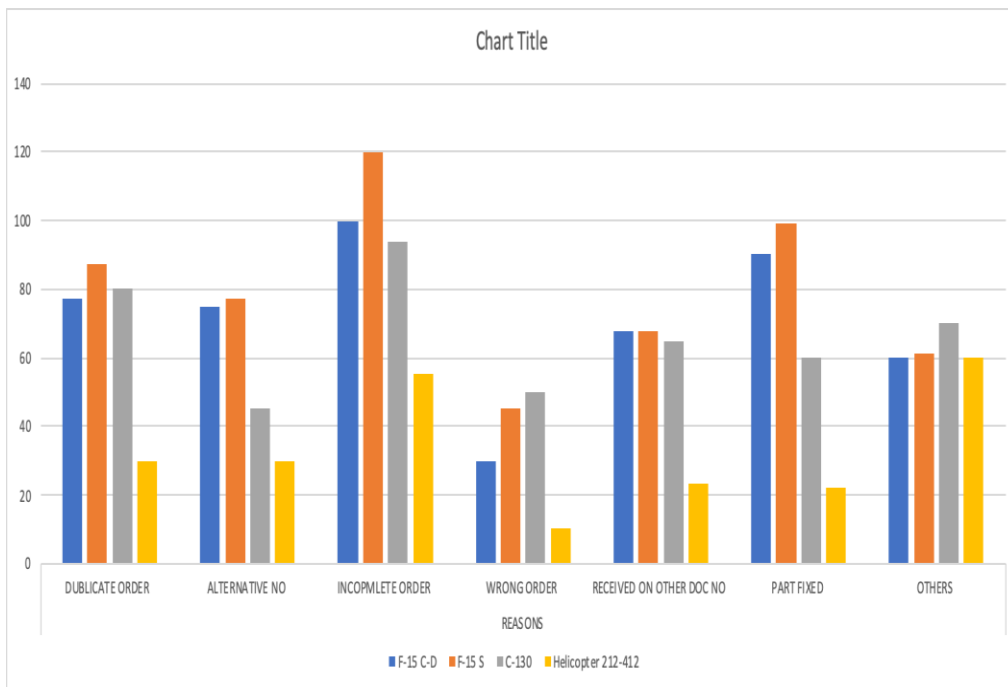


Figure 4. PC reasons

By looking at the Figure 4, it is seen that most of the maintenance squadron share similar reasons for part cancellation. However, it is clear that fighter jet squadrons scored the highest numbers in incomplete orders and part fixed duplicate order. On the other hand, helicopter squadron scored the highest number in others, which indicates that the squadron staff is not specific about the reason when they cancel an order. Furthermore, supply items: part number and document number seem not up to date that leads to part cancellation due to alternative document number. In order to investigate the valid reasons for part cancellation and ways to prevent the high numbers of part cancellation the researcher developed a survey to get the perspective of the population who face this issue in the field directly.

Survey No.1

The goal of this survey is to reach out to the individuals who deal with part cancellation in their field. Their opinions and thoughts are the first step to understand the part cancellation matter and the factors related to increasing the part cancellation numbers.

Q1- Do you think your shop has sufficient manpower?

The answer to this question was a clear indication whether or not the maintenance squadron experiences a high workload due to a shortage of manpower? Most of the participants answered “No,” with 93% of the total respondents. Alternatively, 7% felt that the shop has sufficient manpower and replied, “Yes.”



Figure 5. Survey 1. Q1.

Q2- If you canceled a part, what is the reason you type in to cancel the previous order?

58% of participants after getting the part canceled cancelled the part order saved in the Goldesp others. On the other side, 30% of the participants tend to write that the part was fixed. While the remaining 12% never experienced this issue as shown in Figure 6.

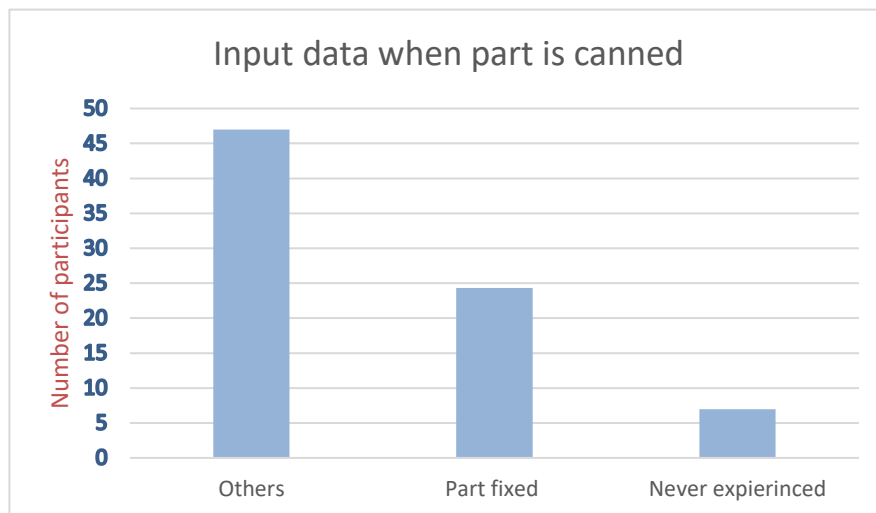


Figure 6. Survey 1.Q2.

Q3- Have you ever canceled an order because it was a wrong order?

As the question was asked to 81 participants, the findings show a high percentage of 84% from the total number of participants has ordered a wrong order then canceled the order 16% of the respondents never ordered a wrong order as illustrated in Figure 7.

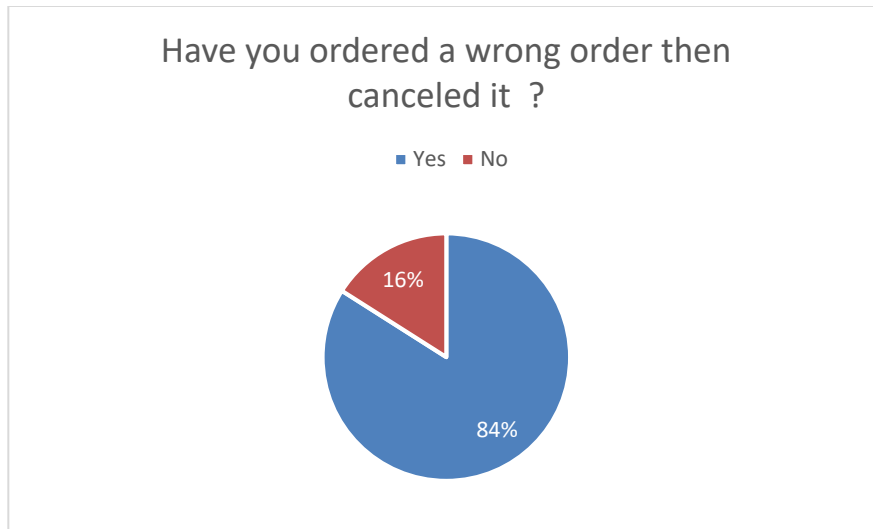


Figure 7. Survey 1.Q3.

Q4- When is the maximum of part cancellation observed?

The maintenance squadron working hours are divided into three shifts as shown in Table 2.

Table 2. Maintenance Working Hours

Working Hours	Shift Name
0700am -1500 pm	A shift
1500 pm – 2300 pm	B shift
2300 pm – 0700 am	C shift

Respondents provided different answers. 44% of the group answered that the maximum of part cancellation activity happens in B shift. The other participants say that C shift experiences maximum part cancellation with 32%. While 24% of the participants believe most of the part cancellation exists in A shift time as shown in Figure 8.

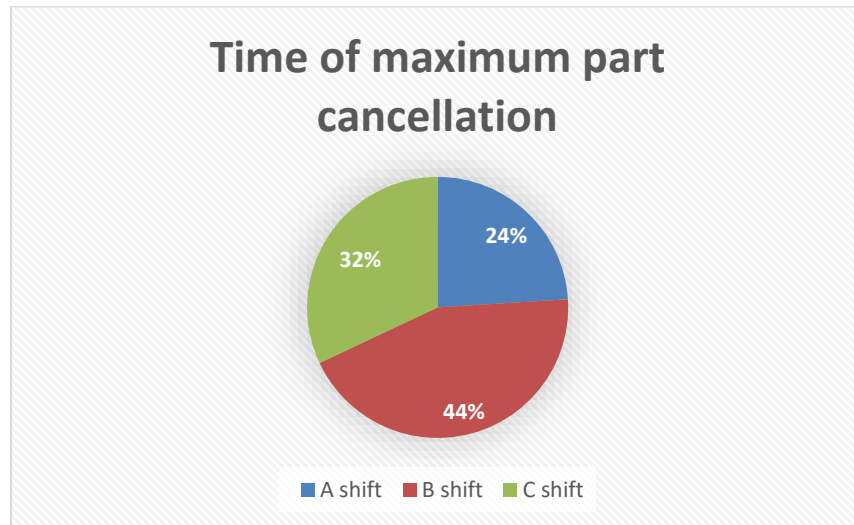


Figure 8. Survey 1.Q4.

Q5- Do you know if part cancellation in your specific shop has increased?

Unexpectedly, the results show a high percentage of 84% of the total number of participants who answered “No.”. 16% of the respondents that answered yes, they are aware the part cancellation exceeded the normal routine limit as shown in Figure 9.

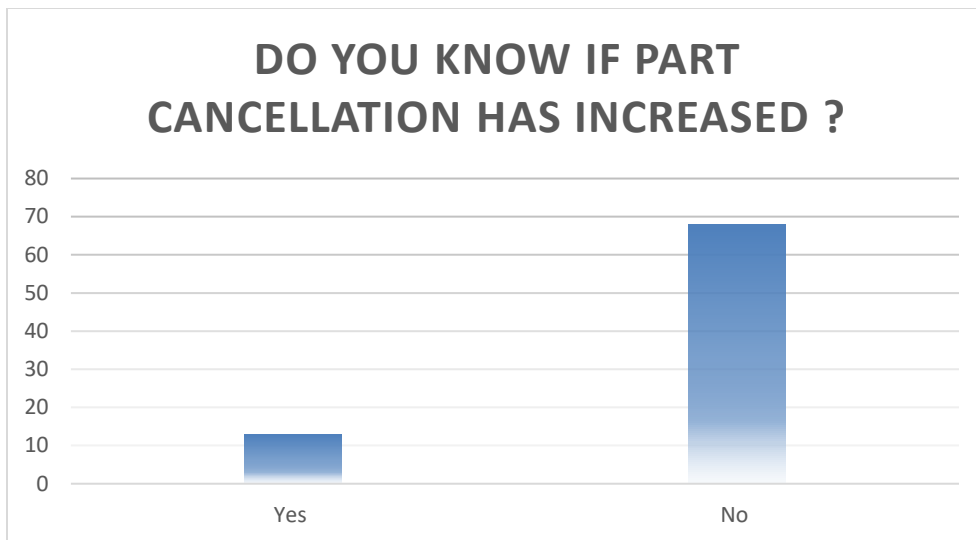


Figure 9. Survey 1.Q5.

Survey No.2

This survey was distributed to (f-15 S -C-D, Helicopter 412-212, C-130) supervisors and officers. Participants showed a higher response as compared with survey 1.

Q1- Does the part cancellation increase in unscheduled maintenance activity?

This question was to examine scheduling and planning in maintenance squadrons. The participants provided different answers. 65 % of participants agreed that scheduled and planned maintenance could prevent part cancellation increase. Furthermore, they provided in their answers that scheduled maintenance is helpful in a way that required parts could be ordered in advance to avoid any part cancellation. On the other hand, 25 % of participants believe that part cancellation numbers are not affected by whether the maintenance activity is scheduled or not. While 10% of the group provided the answer, "I don't know" as shown in Figure 10.

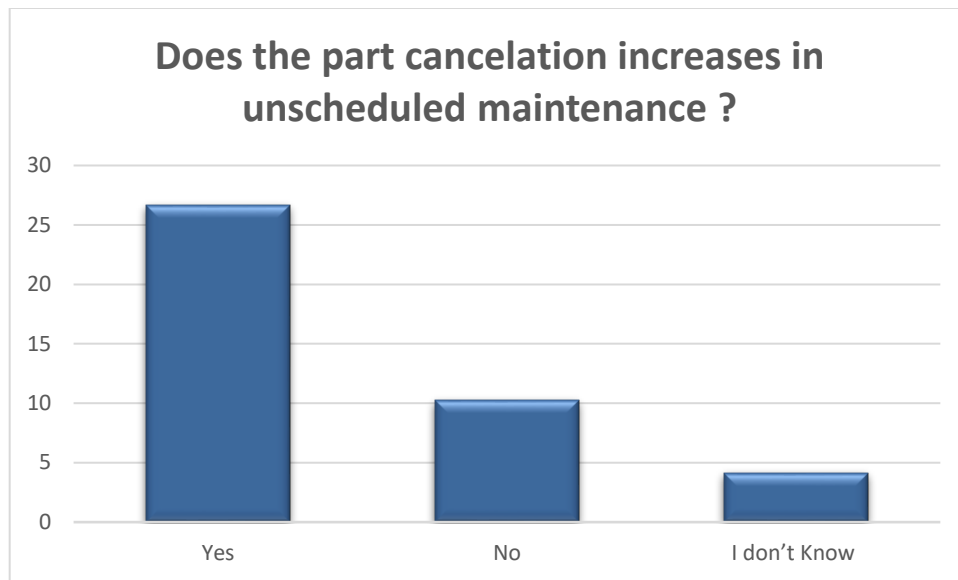


Figure 10. Survey 2.Q1.

Q2- What are the main reasons causing the part cancellation?

Supervisors and officers have a different mindset when compared with aircraft maintenance technicians. The respondents provided different answers as shown in Figure 11.

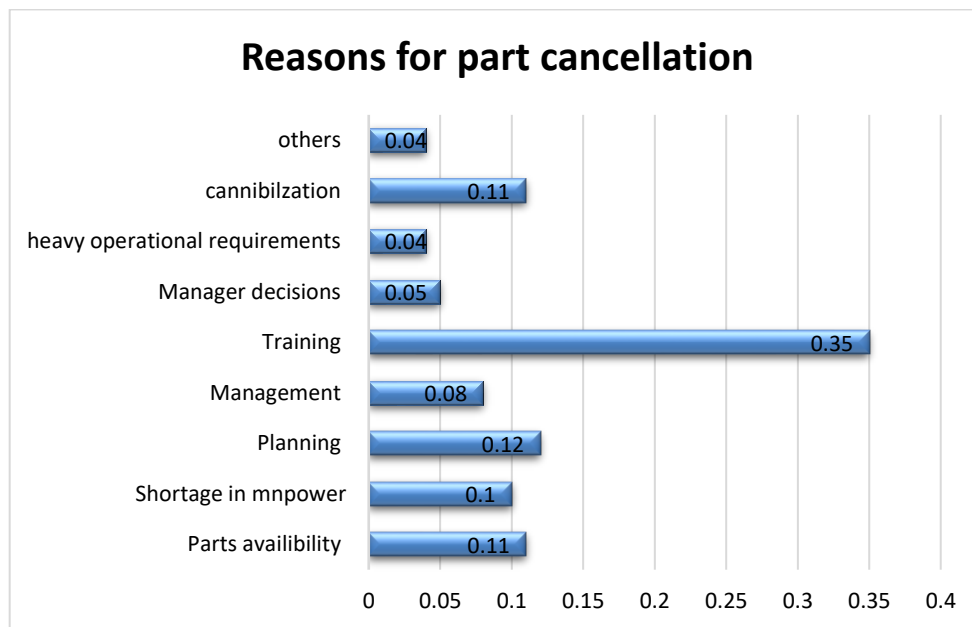


Figure 11. Survey 2.Q2.

Based on the figure shown above, it is clear that supervisors and officers believe that the primary cause of part cancellation is the training 35%. Also, another reason for part cancellation is due to planning 12%. While parts availability, manpower shortage, and cannibalization are important factors affecting part cancellation concern with a significant presence of 11%.

Q3- Do you think the language level and technical knowledge of the maintenance staff are directly proportional to the part cancellation increase?

As expected, the majority of the participants agreed that knowledge and language of the technician plays a major part in part cancellation increase with 92% of the total participants. On the other hand, 8% of the group refers that to the system features, which sometimes delays the part delivery due to required updates for the software and shortage of manpower in the squadron as shown in Figure 12.

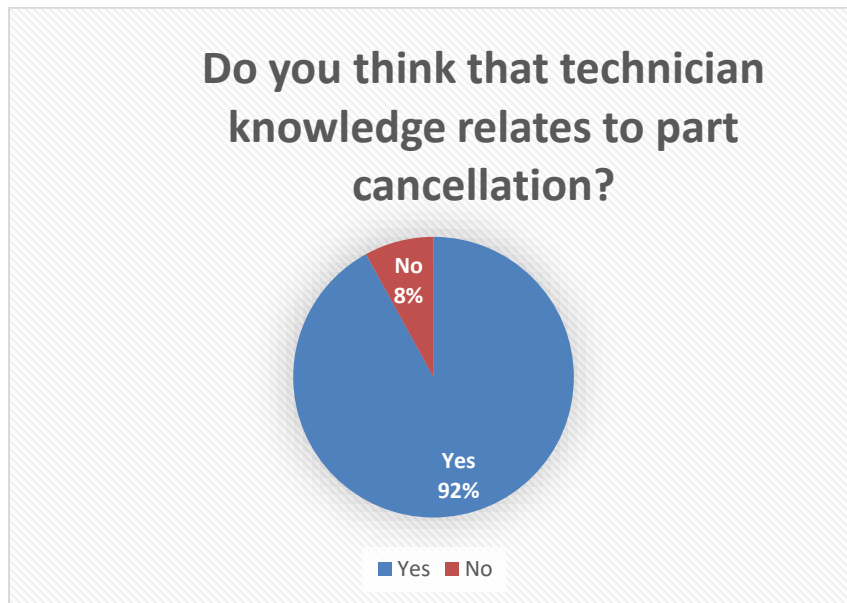


Figure 12. Survey 2.Q3.

Q4- How do you know that the part cancellation numbers are escalating?

Participants were able to choose one or more answers to this question. The majority provided the answer that “ I don’t know” with 45% of the total respondents. On the other hand, 28% of participants come to know by supply calls or notifications. In contrast, 27% reported that they get this information by the logistics wing commander meeting as shown in Figure 13.

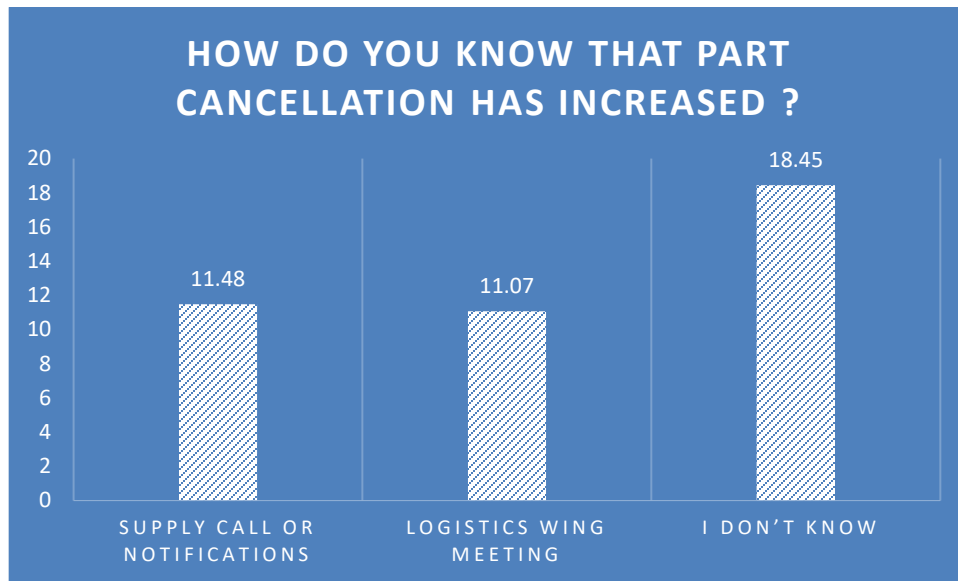


Figure 13. Survey2.Q4.

Q5- Do the analysis and production notify the supervisors when the numbers of part cancellation are high?

Unexpectedly, (70%) of participants have not been notified of part cancellation rises by the production and analysis section. Alternatively, (30%) of the group responded they had been notified by the production and analysis section. Based on the researcher's experience in the field, this is very important that the production and analysis section in supply and maintenance squadrons must be activated in a way that the squadron

commander should be notified on a regular basis to keep track of part cancellations changes as shown in Figure 14.

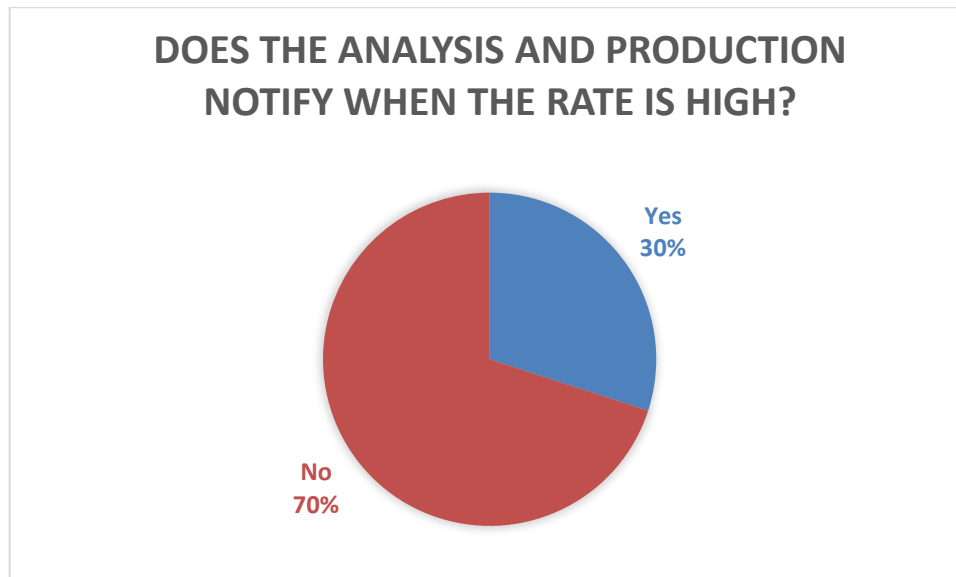


Figure 14. Survey2.Q5.

The Interview

The researcher interviewed F-15 S maintenance squadron commander Major Saleh Alshehri at King Khaled Air Base.

Q1-What are the reasons that are causing part cancellation?

Alshehri replied that many factors in supply and maintenance squadrons contribute to part cancellation process, They are summarized as:

- a- Parts availability and the slow delivery time as the depot supply is located in King Abdulaziz in Dhahran, which is more than 1300 km far from F-15 S squadron.
- b- Manpower shortage, especially with an increase in operational requirements and a high retirement percentage in the last few years.
- c- Cannibalization: Ease of cannibalization sometimes allows the technician to cancel the previous part order instead of waiting for part delivery. He could cancel the part

- d- Goldesp features, allow the incomplete data, wrong requests to process. Often, the Goldesp shut-down or updating which force the technician to find alternatives. Finally, cancel the old order, which was not fulfilled.
- e- Knowledge and language level of the technicians.
- f- Unscheduled maintenance

Q2- What are the most significant among these factors?

Alskehri answered to this question that training plays a significant factor. Other factors still are not neglectable human resources shortage, part availability, and software interfaces.

Q3- How to eliminate them?

Major Saleh said that part cancellation has to exist, but that should be in a reasonable ratio because the possibility of maintenance is high. However, Alskehri explained that part cancellation can be reduced to the minimum by eliminating factors the researcher mentioned earlier and making better coordination between the maintenance and supply. The learning curve must be improved. Categorize and synchronize the reasons for part cancellation to the entire fleets of RSAF to make it easy for a manager, analyze, and find solutions for reducing part cancellation numbers.

Q4-Do you it is possible to link the technician's user account with a mandatory test on the part cancelation process?

Alskehri said this is a great idea and would prevent an unqualified technician from ordering the wrong order. Also, it will contribute positively to minimize part cancelation a massive rise.

4.3 Chapter Summary

In this chapter, the researcher obtained the data by several approaches which are Accessible RSAF database, survey, and interview. The response rate of the survey one low as compared to the survey2 response rate. Data obtained helped to form a clear perspective of part cancelation issue and to come up with suggested ways to decrease the further rises.

V. Conclusions and Recommendations

5.1 Chapter Overview

This chapter presents a summary of part cancellation increments in RSAF and the reasons for the massive rise. Recommends approaches to decrease them. RSAF managers and leaders will find this report helpful to improve the overall aircraft readiness and capability.

5.2 Conclusion of Research

The following conclusion summarizes the key points and recommendations obtained from this research:

Expectedly, as literature reviewed in the C-130 part cancellation process analysis that technician knowledge was the most important contributing factor. The researcher found the majority agreed that the lack of training plays a major factor that contributes to increasing the part cancellation numbers. The majority of maintenance technicians failed in the 2019 English language test. A majority agreed that most of the technicians are not familiar with the process of part cancellation. This finding is very crucial, and RSAF is advised to improve the learning of logistic wing technicians. Although, maintenance culture in RSAF could be improved better to develop a good attitude towards training and assets reliability and maintainability. Furthermore, Lack of supervision is an essential factor that contributes to part cancellation. Hence, a high percentage of part cancellation occurred without the supervisor's presence.

Part cancellation has to exist in RSAF, but the high percentage of part cancellation is a red flag indicating that it could affect RSAF asset reliability and maintainability. The researcher found that data inputs are not well categorized in Goldesp, which makes it

difficult for RSAF engineers and managers to track the causing factors that led to part cancellation increases. Furthermore, the researcher found that some of the part cancellations were bench stock items and not loaded into Goldesp software available in the squadron but in other shops. That is a clear indication of the failure of the material control section in the maintenance squadron. It was found that many aircraft parts have more than one document number. Supply should update the maintenance squadron with an alternative list and updates on a regular basis. This is a high possibility of part cancellation to occur. There is no clear evidence that shows that the supply investigates the repeated part cancellation. Supply should keep track of part cancellation increases and repeated parts failure.

Nevertheless, seven-level technicians are authorized to initiate an order and then cancel it due to manpower shortage along with high operational requirements. The researcher found that part ordering, canceling was carried out by the technician of 3 level and 5 level where it is not authorized. This has contributed to part cancellation numbers escalating.

The majority of participants agreed that the maintenance technician is experiencing a high workload due to the shortage of manpower in every shop , and heavy operational requirements. That will result in a high workload, and the technician could lose concentration in the assigned task. That could cause a loss in aircraft, equipment, and lives. Surprisingly, most respondents agreed that the production and analysis section in maintenance squadrons showed poor conduct regarding follow-up with part cancellation increases in the particular squad. The production and analysis section in supply squadrons did not investigate the repeated part cancellation regarding a specific part. This research found that part cancellation issue increases in unscheduled maintenance.

Finally, while collecting data for this thesis, the researcher found a clear gap between the supply and maintenance squadrons, and that gap increases the chance of a part cancellation. Cannibalization is being carried out when parts aren't available or slow delivery time from the supply. Nevertheless, increases in cannibalization and exceeding the allowed limits is a danger that threatens aircraft's maintainability. Furthermore, some aircraft parts are not suitable for cannibalization

5.3 Investigative Questions Answered

1- What are the factors that are causing part cancellations in RSAF?

The following factors cause part cancellation:

- a- Training
- b- Part availability
- c- Cannibalization
- d- Planning: transforming unscheduled maintenance to scheduled maintenance.
- e- Goldesp software features and interface.
- f- Heavy operational requirements
- g- Manpower shortage in every maintenance squadron.

2- What are the most effecting factors between them?

- a- Training: includes knowledge of the technician of operating with Goldesp and English language level. This is the most important factor that causes part cancellation number to increase.
- b- Part availability: the difficulty of getting the right part in the right time and right place led part cancellation to increase.

- c- Human resources shortage: maintenance squadrons suffer from a shortage in numbers of technicians. Furthermore, continuing with the same numbers without any external support from RSAF headquarter could result in a negative impact on the squadron. There will be a lot of safety issues; if we continue with a shortage, most personnel will lose their concentration while they are working with very sensitive and hazardous materials.

3- How to reduce part cancellation?

Part cancellation has to exist. We can minimize the high numbers of part cancellation, especially unnecessary part cancellation, which could be avoided by applying the following steps:

- a- Link the user account in Goldesp with a mandatory part cancellation test for every individual in maintenance and supply squadron this to ensure that a technician is aware of the all part cancellation of the order before initiating an order.
- b- Squadron commanders of maintenance squadrons are advised to the maximum of unscheduled maintenance to scheduled maintenance.
- c- The material control section should ensure that all parts, bench stock items, and equipment are loaded into Goldesp.
- d- Production and analysis section in supply and maintenance should develop a useful communication link to follow up the part cancellation increases, and report that immediately.
- e- Improve the training of supply and maintenance squadrons.

5.4 Recommendations for Action

1. Improving the training of maintenance and supply personals to perform the assigned tasks efficiently.
2. Production and analysis section in supply and maintenance squadron should be supported with more technicians and directed to be operationally responsible to follow up, investigate, and prevent part cancellation increases.
3. The material control section should ensure that all parts, bench stock items, and equipment are loaded into Goldesp.
4. Conduct a meeting with Goldesp program manager to solve all the issues related to system errors.
5. Monitor cannibalization limits in maintenance squadron.
6. Support maintenance squadrons with enough manpower to fulfill mission requirements
7. Supply squadrons must eliminate the parts with old document numbers from the system to avoid duplicate orders, wrong orders, and parts with alternative document number orders.

Appendix B. Officers and supervisors Feedback

Survey No.2

- 1- Does the part cancellation increase in unscheduled maintenance activity?

- 2- What are the main reasons causing the part cancellation?

- 3- Do you think the maintenance staff's language level and technical knowledge are directly proportional to the part cancellation increase?

- 4- How do you know that the part cancellation numbers are escalating?

- 5- Does the analysis and production section notify the supervisors when the numbers of part cancellation are high?

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14. ABSTRACT
The issue that this study will address is the increase of part cancellation numbers in the Royal Saudi Air Force. To discuss this problem, the purpose of this study will be to explore the leading causes for part cancellation increases in RSAF and find possible ways to eliminate them. Data were collected through an interview with F-15S maintenance squadron commander and survey distributed to RSAF members, including managers and technicians. The outcomes of this study indicate that there is a lack of training, communication, planning, and supervision. The results will help RSAF members to avoid part cancellation increases. Further research is needed to find other factors that might affect the maintenance culture towards asset reliability and maintainability in RSAF.

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