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RESEARCH ARTICLE

DISCOVERING THE KNOWLEDGE TRANSFERS FRAMEWORK ON AERO-COMPOSITE MANUFACTURER IN MALAYSIA

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ABSTRACT - This work elucidated the knowledge transfer method used by an international first tier advanced composite multinational company supplier in transferring the technical knowledge to a Malaysian advanced composite manufacturer. Effective route of knowledge transfer could significantly improve the performance of the company. The process of the transferring knowledge is an ongoing progression of learning, adjusting, and improving. An excellent knowledge transfer could benefit both the knowledge provider and receiver. A "Backward Engineering" investigation on the relationship between the factors during the knowledge transfer process is useful, to be an ideal reference for others. This paper exhibits the technological transfer executed by the aero-composite manufacturer. Method chosen in this study is focus group discussion involving the working committee of respective programme. It was found that a systematic two stages with multi-phases of knowledge transfer has been explored during flat-curvature structures aero-composite project. Tacit and explicit knowledge is important for transferring technical knowledge in industry context. It is noticed that a useful knowledge transfer mechanism has an impact on the performance of organization such as increases in productivity, profits, and growth.

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1.0 INTRODUCTION

Improvements in airplane design have significantly increased airplane complexity and the required number of parts. Each of these design improvement places more demand on the plane manufacturer and its suppliers (Mas, Menéndez, Oliva, & Ríos, 2013). A new project for airplane model AB32 was launched due to discouraging sales of AB30 model. In continuation to the successful Fixed Trailing Edge (FTE) project of AB30 model, Malaysia Advanced Composite Manufacturer (MACM) was again awarded by the first-tier supplier, Advanced Composite Multinational Company (ACMC) with AB32's Wings Aero structure (WA) project. This WA manufacturing project transfer was managed in two phases. When parts require tight tolerances and high level of quality, the fabrication and assembly process also require the same level of precision. MACM has proven their commitment during FTE project, therefore was entrusted with this WA project at a higher production and shipment rate.

The more complex WA project consists of updated multi-panel manufacturing, whereby MACM is lacking in the know-how and technical aspect. The process of transferring information, skills, and technology between ACMC and MACM is crucial, to fulfilling the goals of the business. Doak (2008) mentioned that the process of knowledge transfer is more effective when a capable and reliable partner in supporting and handling is present. Lee and Wu (2010) reported that by transferring good and valuable knowledge from another company, a local expert is required to codify and document the knowledge to benchmark the work and absorb new challenges. Zonooz, Farzam, Satarifar, and Bakhshi (2011) mentioned that information receivers are required to share knowledge through relationships among colleagues. Moreover, spreading knowledge in specific groups is good, but sharing via tacit knowledge is preferable.

Zhou, Deng, Hwang, Zhao, and Zhang (2022) mentioned that organizational management (i.e., organizational climate and incentive mechanism) plays an active role in increasing members' externalization willingness, which is highly possible to convert tacit knowledge and enhance the coding level of knowledge, thereby improving the effect of tacit knowledge externalization in international construction projects.

There are three overarching goals of a good introduction: 1) ensure that you summarize prior studies about the topic in a manner that lays a foundation for understanding the research problem; 2) explain how your study specifically addresses gaps in the literature, insufficient consideration of the topic, or other deficiency in the literature; and 3) note the broader theoretical, empirical, and/or policy contributions and implications of your research.

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A well-written introduction is important because, quite simply, you never get a second chance to make a good first impression. The opening paragraphs of your paper will provide your readers with their initial impressions about the logic of your argument, your writing style, the overall quality of your research, and, ultimately, the validity of your findings and conclusions. A vague, disorganized, or error-filled introduction will create a negative impression, whereas, a concise, engaging, and well-written introduction will lead your readers to think highly of your analytical skills, your writing style, and your research approach. All introductions should conclude with a brief paragraph that describes the organization of the rest of the paper.

2.0 GENERAL FRAMEWORK OF KNOWLEDGE TRANSFER

2.1 Explicit Knowledge

Pederson (2003) described explicit knowledge as knowledge of books. Liyanage, Elhag, Ballal, and Li (2009) added to the definition stating that this knowledge is also the data that is recorded in documents or on a computer system. Explicit knowledge can be expressed, explained, and codified easily in comparison to tacit knowledge. Explicit knowledge is the knowledge that is codified and transferable in a formal, systemic language (Polanyi, 2009). It is the knowledge that can be found in contracts, manuals, databases, licenses, or embedded in products. Badaracco and Badaracco (1991), and Nonaka and Takeuchi (1995) noted that explicit knowledge can travel and be transferred more at ease across organizational boundaries as it is much easier to codify and articulate. According to the research conducted by Bhagat, Kedia, Harveston, and Triandis (2002), organizations located in individualistic cultures are better able to transfer and absorb explicit knowledge than tacit. Lawson and Potter (2012) also viewed explicit knowledge as knowledge that is documented, structured, and easily transferable which supports previous literature's definition of explicit knowledge. Considering shared explicit knowledge first, this is information in textbooks and manuals provided by an organization for people to learn from enabling individuals to acquire additional human capital (Argote, Guo, Park, & Hahl, 2022; Butler, Le Grice, & Reed, 2006).

2.2 Tacit Knowledge

Implicit or tacit knowledge, however, is difficult and sometimes impossible to capture and diffuse (Koulopoulos & Frappaolo, 1999; Pederson, 2003) but it adds more value to organizations. Tacit knowledge is the quality of knowledge within the individual itself based on the expertise, duration of work experience and also resulting from a strong work culture. It is difficult to be formalized or codified because it requires multiple contexts (Klippert, Preißner, Rust, & Albers, 2022; Seidler-de Alwis & Hartmann, 2008). Alavi and Leidner (2001) claimed that some researchers attempt to highlight that tacit knowledge is more valuable than explicit knowledge or vice versa. Tacit knowledge forms the background necessary for assigning the structure to develop and interpret explicit knowledge (Polanyi, 1958). Tacit knowledge is knowledge made up of knowledge that has a personal quality, making it difficult to formalize and communicate. Tacit knowledge is embodied in individuals, such as employees with expertise and know-how resulting from years of on-the-job experience, as well as in organizations, such as that with an established brand name, shared routines and company culture. This is due to the fact that as this knowledge is often embedded in the individual's cognitive processes, it is more difficult to communicate and transfer, thus this would imply that the transfer of tacit knowledge requires richer context, and more than mere codification (Daft & Lengel, 1986). Organizations located in collectivist cultures are better in the ability to transfer and absorb the knowledge that is more tacit. The transfer of tacit knowledge is typical of those collectivistic cultures, like the Japanese, where people usually learn from each other, according to a sort of ''collective tuning'' (Canestrino, 2004). The more tacit the knowledge is, the more difficult it is to transfer through strategic alliances (Mazloomi Khamseh & Jolly, 2008).

3.0 METHOD AND DESCRIPTION

The aim of the work was to explore the framework for the transfer of aero-composite technical know-how. A "Backward Engineering" approach was adopted by investigating the aero-composite-making organisation. For the data collection, focus group discussion interview method was adopted, where employees at different departments were invited for the interview session (Nyumba, Wilson, Derrick, & Mukherjee, 2018). Head of the project program and representatives from the department of human capital, finance, procurement, and engineering were interviewed with a total of 8 active personnel. The interview was held in the respective company's meeting room. The findings obtained were blended with the literature to enhance the discussion and conclusion of the work.

The aero-composite-making company is a local Malaysian-owned company which served as a supplier for a multinational giant aerospace manufacturing company. It was established in 1990 with the Malaysia Ministry of Finance incorporated as the principal shareholder. The main mission of the company is to develop people, capabilities, and products in the aerospace advanced composite industry. In order to sustain the vision and mission of the company and nation, long-term exploration of advanced composite technical knowledge is the priority.

A knowledge transfer on the advanced composite technical know-how has been executed between ACMC and MACM. The full fledge knowledge has been transferred to MACM via a special expert training session. This work will focus on the method or process of knowledge transfer within this project from the training session until mass production.

4.0 FINDINGS

The findings of the focus group discussion suggest that the process of knowledge and technology transfer for WA project was managed and segregated into two major stages. Stage A represents the "Flat" panels and Stage B consists of the more complicated "Curvature" panels. Figure 1 presents the framework phases of knowledge transfer from the beginning until the full production of the project. The number of personnel involved in this knowledge transfer mechanism increased throughout the phases. The composite components work transfer of WA project kicked off in 1999.

When the WA project was transferred to MACM by ACMC, there was a gap in the technological level as MACM was lacking the know-how ability to manufacture the new and more complicated WA package. The previous FTE package comprised the manufacturing and assembly of only top and bottom skin panels with five internal ribs. In contrast, the bigger WA project consisted of updated structure design, characteristics, functionality, customer quality passing rate, and manufacturing process.

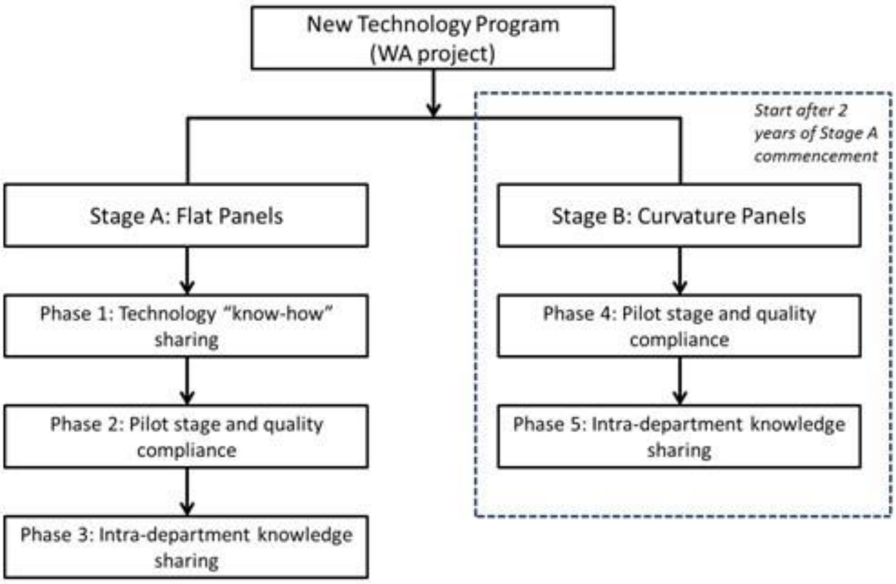

Figure 1. Two major stages of WA project

5.0 STAGE A: FLAT PANELS

Stage A of the WA work transfer includes the leading edge consisting of 24 panels, the trailing edge consisting of 22 panels, and the aileron consisting of 10 panels. In addition, the package includes the underwing, falsework, and overwing panels for both left and right sides.

5.1 Phase 1

For the initial Phase 1 of the KT mechanism, four (4) of the MACM technical staff were involved in the technical training in Salisbury, England for the period of two (2) weeks. So, this was a full KT exercise for the MACM staff with the objective of acquiring the necessary know-how on the manufacturing process. The MACM staff were comprehensively trained in the approved methods, which focused on the lay-up process and assembly of the parts. This KT process was significant in ensuring that the components were to be manufactured as per the required specifications and quality standards. As this technological transfer involved a face-to-face strategy and a very low number of participants, the knowledge acquisition was considered successful. The business-oriented customer-supplier type of relationship was in place and the transfer project also involved the handover of all the related equipment, such as composite lay-up mould tools, trimming tools and assembly jigs to MACM.

5.2 Phase 2

Following the successful approach in Phase 1, the trained MACM staff began the manufacturing and assembling of the First Part Qualification (FPQ) panel for the WA package at MACM plant in 1999. In this Phase 2, the processes were carefully monitored by two (2) ACMC staff to ensure all the manufactured and assembled steps were accurately executed. In this phase, both ways of sharing knowledge concurrently existed between ACMC and MACM staff. The finished FPQ panel was examined using non-destructive testing (NDT) and a multi-axis scanner. It was considered a pass as it met the quality requirement. Subsequently, MACM produced the First Article Inspection (FAI) panel, whereby this package was sent to ACMC in England for customer verification. The FAI panel was successfully integrated into the wings of the actual aeroplane, thus confirming the success of the technological transfer. Hence, the four (4) trained MACM staff were certified as qualified persons to handle the WA project. Sequentially, MACM acquired the necessary customer approvals to commence full production of Stage A parts in MACM plant.

5.3 Phase 3

The initial production rate at the time was set at 10 shipsets per month, which were to be gradually increased in the following years. Hence, there was a need to increase the number of staff involved with the manufacturing process due to the required shipset delivery rate. Therefore, the four (4) certified MACM staffs were responsible to transfer the know-how to the other 14 unskilled MACM staff. The buddy system, a method used by MACM is considered as horizontal KT, where it only involves the intra-department within MACM. By implementing this system, the hands-on skills were shared by the certified MACM staff with their buddies using tutoring techniques. The formal buddy system was essentially beneficial to the buddies, where it became an unstructured knowledge-sharing medium. Consequently, this resulted in the expansion of the certified personnel and improvement of the production rate for the Stage A package.

6.0 STAGE B: CURVATURE PANELS

The KT was successfully executed in WA project Stage A, and this achievement was recognized by ACMC. In continuation, the Stage B programs were transferred to MACM after two (2) years of commencement of Stage A full production. Stage B package comprised of the more complex curvature panels such as spoilers, movables fairings, aft fixed fairings, aileron sharklet, and top covers. These involved the manufacturing and assembly of 22 panels at the initial rate of eight (8) shipsets per month.

6.1 Phase 4

Going into the Stage B project, ACMC again provided two (2) more dedicated trainers in MACM to conduct the hands-on training for all the related employees. The major skill involved in Phase 4 is the lay-up technique. The KT process in Phase 4 is similar to Phase 2 of Stage A, where the finished FPQ panel and subsequently FAI panel were successfully verified by ACMC. MACM obtained the customer approval to begin full production of Stage B panels in MACM plant.

6.2 Phase 5

There was a necessity to increase the number of staffs involved with the manufacturing process to achieve the required production rate. Therefore, the buddy system was again adopted in Phase 5 as a method to increase the number of certified MACM staff. This phase is similar to Phase 3, and the result at MACM was outstanding, thus still considered the main in-house training and development among MACM staff. This method enables the increment of the manufacturing rate to the current noteworthy rate of 56 shipsets per month. The projection moving forward is to support the rate of 75 shipsets per month in the year 2020.

7.0 DISCUSSION

The WA project that consists of Stage A and Stage B was successfully executed and an extended contract has been awarded until 2022. The finding provides evidence that the scrap cost per revenue was recorded at 1.1%. This manufacturing quality figure reflects the excellent achievement of knowledge transfer at MACM. A MACM head of department told: “The WA project transfer at MACM was an example of a successful customer-supplier relationship. The process of technology transfer was smoothly implemented and fully supported by ACMC. The customer complaint per delivered quantity was logged at 0.1%, therefore showing the tremendous quality achievement”.

As revealed from the study, the appropriateness of a mechanism for knowledge transfer does not only depend upon the tacitness of knowledge. The study explains that factors other than the tacitness of knowledge have a predominant role to play while exploring an appropriate knowledge transfer mechanism. For example, in the knowledge transfers in Salisbury, England, both explicit and tacit knowledge were used during the process. A systematic and structural package of explicit knowledge has been adopted by ACMC trainers to deliver the know-how to MACM staff. At the same time, the personal tacit knowledge of the trainers further enhances the level of knowledge during the delivery to MACM staff. A similar practice occurred for the horizontal knowledge transfer phase within MACM, where the buddy system was introduced. A collaborative environment of MACM and ACMC as well as open communication between the project stakeholders are acknowledged as key factors that imply effective knowledge transfer which leads to successful outcomes. Particularly, mutual trust and shared collaborative culture contribute to the success of the project partners (Bellini, Aarseth, & Hosseini, 2016; Zieba, 2021).

8.0 CONCLUSION AND IMPLICATIONS

One of the crucial elements of an organization’s sustainable competitive advantage is knowledge transfer. This paper discovers the mechanism of knowledge transfer being adopted by an aero-composite company, which is proven as a successful method in industrial partnerships. An interesting finding about the knowledge transfer method in the real industry is tacit and explicit knowledge which play an important role. A systematic two stages with multi-phases of knowledge transfer has been explored for flat-curvature structures project. The most convincing way to transfer technical knowledge shall include tacit and explicit knowledge. Much work remains to be done because there are some other variables, namely, nature of the personnel, trust, difference of culture, and pre-recruitment program that might also have a significant influence as far as knowledge transfer is concerned. This paper contributes some groundwork or exploration of the real industry know-how transfer, which may benefit stakeholders in future. Moreover, a similar method could be adopted for future knowledge transfer programmes dealing with international business contexts.

9.0 ACKNOWLEDGEMENT

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