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Conceptual Paper: Indoor Air Quality Onboard Warship in Related with Occupancy Stress Level

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A B S T R A C T

The indoor air quality (IAQ) within a working environment holds paramount importance in ensuring optimal productivity and the well-being of occupants. IAQ plays a pivotal role in influencing the health and overall welfare of individuals in confined spaces. This significance magnifies within the context of a warship, where personnel endure prolonged periods within limited quarters. The quality of onboard air emerges as a critical determinant impacting personnel stress levels, subsequently reverberating through performance and holistic wellness. This paper aims to introduce a novel conceptual framework aimed at investigating the intricate interplay between indoor air quality and occupancy stress levels aboard warships. Rooted in the principles of Social Cognitive Theory, this framework encompasses three distinct variables: the independent variable of environmental factors (specifically indoor air quality), the dependent variable encompassing behavioral facets (crew stress levels), and a mediating variable, self-efficacy, seamlessly bridging the gap between the aforementioned independent and dependent variable. Prior research has indicated a lack of studies investigating the relationship between indoor air quality and occupancy stress levels. Therefore, it is recommended that the proposed framework be empirically tested to validate its applicability.

Keywords: Indoor Air Quality, Social Cognitive Theory, Warship Crew Stress Level.

1. Introduction

According to Kent (2021), sustainable design seeks to reduce negative impacts on the environment, and the health and comfort of occupants, thereby improving performance. This is also supported by Stefano (2020) who describe the basic objectives of sustainability are to reduce consumption of non-renewable resources, minimize waste, and create healthy, productive environments. The essential element of sustainable design is indoor environmental quality including air quality, illumination, thermal conditions, and acoustics (Wame, 2019). Naval ships are made up of confined and enclosed spaces where air circulation is limited. For the Royal Malaysian Navy's (RMN) ageing assets that are still in service, inefficient ventilation is one of the concerns (M.Zahaba, 2021). It is also support by by Ariffin et al (2021) Poor indoor air quality (IAQ) onboard has been reported to cause unhealthy and uncomfortable indoor environment and even lead to equipment breakdown. Nonetheless, indoor air quality onboard warship will give detrimental effect to the crew and machinery. According to Dąbrowiecki et al. (2015), symptoms that occur in ships or vessels are termed as Sick Boat Syndrome (SBoS). Sick Boat Syndrome is a term used to describe a range of health problems that can occur as a result of exposure to poor indoor air quality on boats and ships. The term is similar to Sick Building Syndrome, which is used to describe similar problems in buildings. The symptoms of Sick Boat Syndrome can include headaches, fatigue, dizziness, nausea, respiratory problems, skin rashes, and eye irritation. Based on previous study on crew satisfaction toward working environment onboard war ship involving 114 crew, the result for the first variable which is work related anatomy symptoms stated that all respondents were dissatisfied with the majority of the items in this variable, which ranged from 44.5% to 61.7%. Meanwhile, the items about anatomy, nausea, and symptoms have a neutral result, which carries a 50.8% result, with an average of 52.2%.

It has now become a matter of increasing public concern, prompted partly by the emergence of new indoor air pollutants, by the isolation of the indoor environment from the natural outdoor environment in well-sealed working environment. According to Julius (2021), poor indoor air quality can lead to discomfort, ill health, and, in the workplace, absenteeism and lower productivity. Thus, good indoor air quality safeguards the health of the workplace occupants and contributes to their comfort and well-being. The idea also support by Hodgson (2002), indoor environment in a restricted space is a complex and dynamic combination of physical, biological, and chemical factors that can affect the occupants' health and physical reactions . Department of Occupational Safety and Health Ministry of Human Resource Malaysia has introduced the Industry Code of Practice on Indoor Air Quality 2010 to increase the compliance of designated workplaces (ICOP, 2010). This ICOP has been drawn up to ensure employees and occupants are protected from poor indoor air quality that could adversely affect their health and well-being, and thereby reduce their productivity. American Environmental Protection Agency EPA (1997) also reported that indoor environments can have pollutant levels higher than outdoor. Hence, this study aims to evaluate relationship between IAQ and stress level of crew onboard Warship within parameters of compliance with the relevant standards, namely the Industry Code of Practice on Indoor Air Quality 2010 (ICOP IAQ 2010) by Department of Safety and Health Malaysia (DOSH, 2010), United States Environmental Protection Agency (US EPA 2006) by US EPA (2006) and Malaysian Ambient Air Quality Standards (MAAQS 2013) by Department of Environment Malaysia

(DOE, 2013). According to Kim S,Lee Y (2020), majority of previous research related to Indoor Air Quality has focus on other mode of transportation which ship have received less attention. Meanwhile, little attention has given to relationship of physical indoor environment factor toward occupancy stress level (Cooper, 2021). Finding thus far has been inconclusive within implication factor in paying special attention to air quality based on Sustainable Development Goal 2015. Previous research demonstrates a lack of holistic studies on working environment in the element of working environment conducted on-board warships.

2. Methodology

This research start by collecting the data using several database which is Science Direct, Ovid, ProQuest, Google Scholar, UiTM Library and Springer Link. In addition, identification of relevant theory also take place in order to employ throughout the study. Key variable has been critically derive from theory in support with sub variable and a few attribute to anchor the study.

3. Result and Discussion

3.1 Theory selection - Social Cognitive Theory

This research employ Social Cognitive Theory (SCT). It was established by Albert Bandura in 1986. Cluster of theory is fall under Sociology cluster which is an extension version of Social Learning Theory (SLT) by Bandura in 1977. It's also support from social learning and imitation theory (social sciences). This theory were used to post that learning occurs in a social context with a dynamic and reciprocal interaction of the person, environment, and behavior (Bandura, 1986). Refer to Figure 3.1, SCT acknowledges the constant interaction that exists between the individual and environment, both structural and social, to shape behavior. The theory will help researcher to explain independent variable (IV) of how Indoor Air Quality to influence or explain the Dependent Variable (DV) onboard warship crew stress level. This theory include clear concept of relationship within human behavioral, personal and environment. It's also associated with variable and dimension in this study. This theory also derive based on strong premises thus come out with appropriate framework to support the finding of study

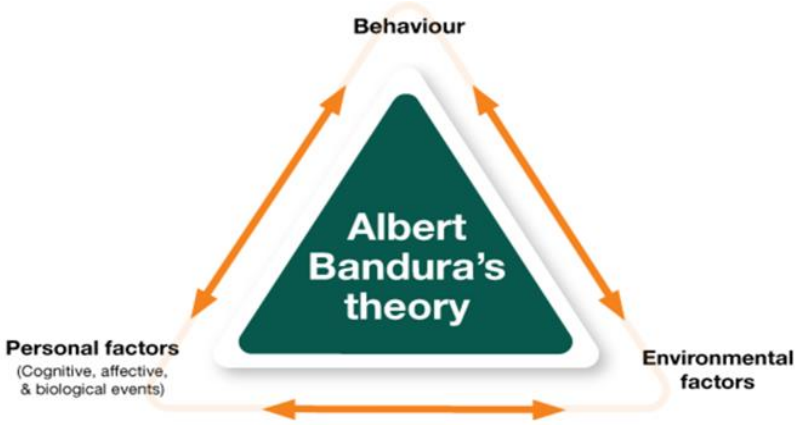


Figure 3.1 Social Cognitive Theory by Bandura 1986

Refer to Figure 3.2, there are a few theory support Social Cognitive Theory namely Theory of Planned Behavior for behavioral variable. The theory explain that the likelihood of a particular behavior can be predicted by the individual's intention to perform that behavior (Ajzen, 1991). Researcher highlighted stress as dependent variable in support with two sub variable which is stress response and stress triggered. The theory also bridge up by mediating variable which is Self-Efficacy Theory incorporate with personal variable. Based on Schwarzer and Fuchs (1996) for a version of this model that incorporates risk perceptions and behavioral intention, as well as components of the action phase of behavior change. Sub variable of personal variable is knowledge and self-efficacy. While self-efficacy outline with construct of vicarious experience and performance outcome. Another theory which support independent variable is Maslow Hierarchy Needs Theory. According to Abraham Maslow (1943), the hierarchy of needs is a psychological idea and also an assessment tool, particularly in education, healthcare, air, and social work. Dependent variable is Environment and supported by sub variable of indoor air quality including physical parameter and air contaminant.

3.2 Dependent Variable

Indoor air quality can have a significant impact on occupant stress levels. Poor indoor air quality can cause a range of physical symptoms, such as headaches, fatigue, and respiratory problems. These symptoms can increase stress levels and reduce overall well-being. Additionally, poor indoor air quality can also impact cognitive function, which can further increase stress levels. Crew stress level identified as Dependent Variable in this study. There are related theory supported this attribute which is Theory of Planned Behavior (TPB), The theory of planned behavior is an extension of the Theory of Reasoned Action and thematic-attribute attitude model (Fishbein & Ajzen, 1975). One of the earliest and widely applied models, TRA was introduced by Fishbein and Ajzen (1975) and assumes that individual behavior can be controlled at will. TPB model which can more accurately predict and explain

human behaviour. The theory of planned behavior (TPB) suggests that the likelihood of a particular behavior can be predicted by the individual's intention to perform that behaviour (Azrai, 2019). Intention captures the motivational factors that influence behavior, e.g., to homeowners' preferences towards colour on the common space utilize impact to the psychology.

TPB has proved to be a successful analysis tool for consumers' behaviours (Lobb 2017). In accordance with Mullan (2020), The theory of planned behaviour (TPB) is one of the best studied and applied theories in the human behavioural research Furthermore, the TPB is used to explain the intention and behaviour of consumers in many studies (Pham, 2019). According to Stern (2019), TPB is considered as one of the most useful frameworks in explaining human behaviour in the wide range of fields and more specifically it has great applicability in the field of environmental psychology(Paul & Lin, 2022). Therefore, this theory support one of the variable (which is behavioural) on the Social Cognitive Theory. Meanwhile, behavioural intention is defined as individual's readiness to perform a certain behaviour and it is assumed as an immediate antecedent of the actual behavior (Ajzen, 1991). The diagram of TPB and the brief explanation are shown as Figure 3.3. Evidence suggests that the TPB can predict 20-30% of the variance in behaviour brought about via interventions, and a greater proportion of intention (Morris et al., 2012). Strong correlations are reported between behaviour and both the attitudes towards the behaviour and perceived behavioural control components of the theory. Therefore, TPB is proposed to understand how behavioural factor contribute as dependent variable in the social cognitive theory.

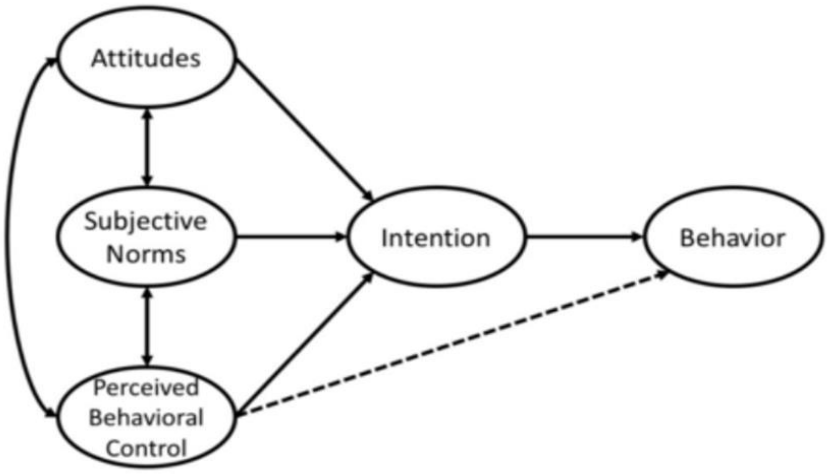


Figure 3.3 Theory of Planned Behavior by Ajzen, 2005

There are several factors that can contribute to poor indoor air quality, including inadequate ventilation, high humidity levels, and the presence of pollutants such as mold, dust, and volatile organic compounds (VOCs). Addressing these issues through proper ventilation, air filtration, and regular cleaning can help improve indoor air quality and reduce occupant stress levels. On the other hand, good indoor air quality can have a positive impact on occupant well-being and productivity. Research has shown that improving indoor air quality can lead to reduced absenteeism, improved cognitive function, and increased job satisfaction among building occupants. Therefore, it is important to prioritize indoor air quality in building design and maintenance to ensure a healthy and comfortable indoor environment.

3.3 Independent Variable

IAQ already identify as independent variable which IAQ on ships can be affected by several factors, including ventilation, humidity, and the presence of pollutants. Poor indoor air quality can contribute to a range of health problems and discomfort for crew members and passengers, including respiratory problems, headaches, and fatigue. Maslow's hierarchy of needs is an idea in psychology proposed by American psychologist Abraham Maslow (1943). His theories parallel many other theories of human developmental psychology, some of which focus on describing the stages of growth in humans. Matrevile (2021) also agree that the theory is a classification system intended to reflect the universal needs of society as its base, then proceeding to more acquired emotions. The hierarchy of needs is split between deficiency needs and growth needs, with two key themes involved within the theory being individualism and the prioritization of needs (Kim, 2019). While the theory is usually shown as a pyramid in illustrations, Maslow (1943) himself never created a pyramid to represent the hierarchy of needs. The hierarchy of needs is a psychological idea and also an assessment tool, particularly in education, healthcare and social work. The hierarchy remains a popular framework in sociology research, including management training and higher education.

Refer to Figure 3.4, Physiological needs are the base of the hierarchy. These needs are the biological component for human survival. According to Maslow's hierarchy of needs (1943), physiological needs are factored into internal motivation. It support by Azrai (2019) which humans are compelled to satisfy physiological needs first to pursue higher levels of intrinsic satisfaction. To advance higher-level needs in Maslow's hierarchy, physiological needs must be met first. This means that if a person is struggling to meet their physiological needs, they are unwilling to seek safety, belonging, esteem, and self-actualization on their own (Kim, 2019). Physiological needs include Air, Heat, Clothes, Hygiene, Light Water, Urination, Food, Excretion, Shelter, and Sleep. These physiological needs must be met for the human body.

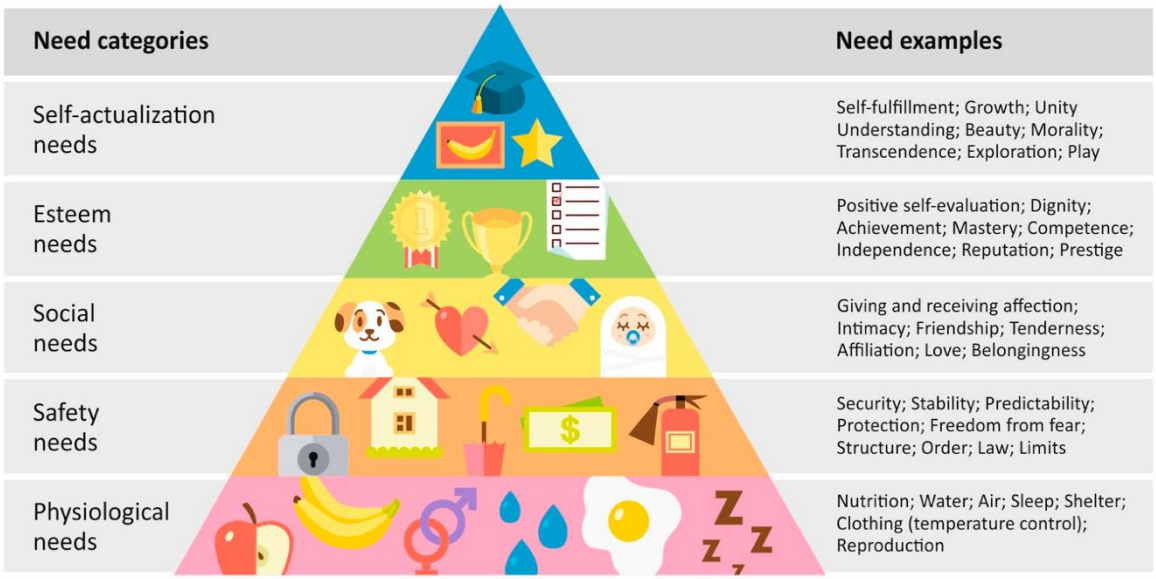


Figure 3.4 Maslow Hierarchy Needs Theory by Maslow, 1943

One of the main challenges in maintaining good indoor air quality on ships is ensuring adequate ventilation. Ships are typically sealed environments, which can trap pollutants and moisture inside. Proper ventilation is essential to remove pollutants and maintain healthy air quality. Ventilation systems should be designed to ensure that fresh air is circulated throughout the ship and that indoor air is properly filtered. Humidity is another important factor in ship indoor air quality. High humidity can contribute to mould and mildew growth, which can cause respiratory problems and other health issues. To control humidity levels, ships should be equipped with dehumidification systems, and crew members should be trained to monitor and control humidity levels in their living and working areas. Pollutants such as dust, smoke, and chemicals can also contribute to poor indoor air quality on ships. To minimize these pollutants, ships should be properly cleaned and maintained, and smoking should be prohibited in enclosed areas.

In addition to these measures, IAQ served as independent variable in this research which clearly part of the element in physiological need as per Hierarchy Needs Theory. It is give direct support to the social cognitive theory, crew members and passengers can take steps to improve indoor air quality on ships. These include avoiding the use of harsh chemicals and fragrances, opening windows and doors for ventilation when possible, and reporting any signs of poor air quality to ship management.

3.4 Mediating Variable

Self-Efficacy Theory (SET) is a subset of Bandura's (1986) social cognitive theory. The latter construct refers to the perceived positive and negative consequences of performing the behaviour. Self-efficacy is an individual's belief in their capacity to act in the ways necessary to reach specific goals. Self-efficacy affects every area of human endeavour (Trevor, 2019). By determining the beliefs a person holds regarding their power to affect situations, self-efficacy strongly influences both the power a person actually has to face challenges competently and the choices a person is most likely to make. These effects are particularly apparent, and compelling, with regard to investment behaviours. Self-efficacy serve as a mediating variable in the relationship between crew stress level and indoor air quality. First, high levels of occupational stress can have a negative impact on an individual's perception of their ability to manage stress and perform their job tasks effectively. This can lead to a decrease in self-efficacy, which can then further exacerbate the stress response and lead to a negative cycle of stress and reduced self-efficacy. On the other hand, individuals with high levels of self-efficacy may be better equipped to cope with occupational stress, including stress related to indoor air quality. They may be more likely to take proactive steps to manage stress, such as seeking social support or engaging in stress-reducing activities, which can then help mitigate the negative effects of indoor air quality on stress levels. Therefore, self-efficacy can potentially serve as a mediating variable in the relationship between crew stress level and indoor air quality. Specifically, high levels of self-efficacy may help buffer the negative effects of indoor air quality on stress levels, while low levels of self-efficacy may exacerbate the negative effects of indoor air quality on stress levels. Refer to Figure 3.5, Self-Efficacy variable will be supported by four variable which is performance accomplishment, vicarious learning, verbal encouragement and emotional states. This study will comprehend the sub variable of vicarious learning and performance outcome as it closely related to the subject and nature of environment on board warship. In addition, level of knowledge amongst ship crew will determine on their behaviour and understanding of IAQ. Philosophical assumption which is lack of knowledge in IAQ also coherent in support with the element.

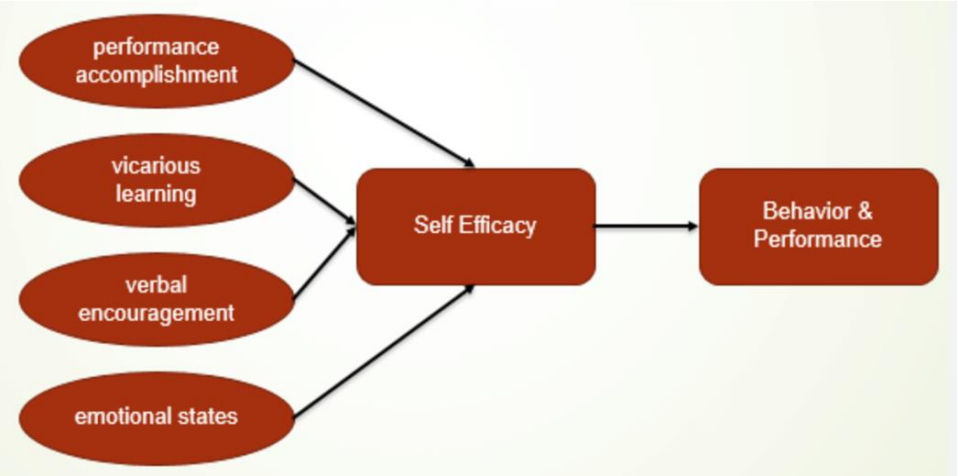


Figure 3.5 Theory of Self Efficacy by Bandura 1986

Overall, self-efficacy can play an important role in an individual's ability to cope with occupational stress and may be an important factor to consider in understanding the relationship between crew stress level and indoor air quality. Thus, Self-Efficacy element and lack of knowledge have become main pillar in determine mediating variable.

3.5 Relationship of Theory

Social Cognitive Theory (SCT) is the main theory that anchor in the theoretical framework that emphasizes the role of social and cognitive factors in shaping individual behaviour. There are constant relationship in between all variable. First, Theory of Planned Behaviour (TPB) in support SCT and TPB share some similarities in that they both consider the role of cognitive factors in shaping behaviour. However, TPB focuses specifically on the role of attitudes, subjective norms, and perceived behavioural control in predicting behaviour. In contrast, SCT takes a broader view of cognitive factors, including self-efficacy, observational learning, and outcome expectations.

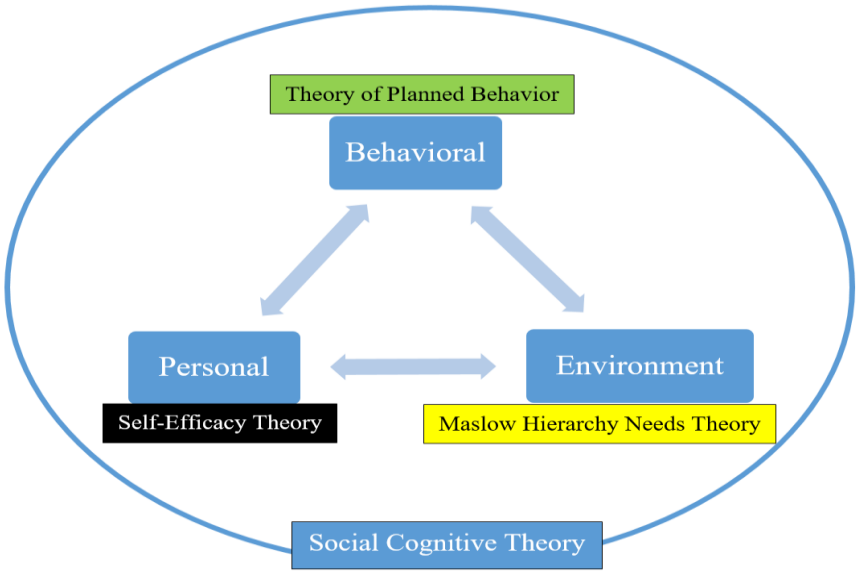
Maslow's Hierarchy of Needs Theory in contrast with SCT which Maslow's Hierarchy of Needs Theory both emphasize the importance of motivational factors in shaping behaviour, they differ in their approach. Maslow's theory proposes that individuals have a hierarchy of needs that must be met in order to achieve self-actualization, with physiological needs at the base of the hierarchy and self-actualization at the top. SCT emphasizes the role of cognitive factors, such as self-efficacy, in shaping behaviour. In addition, SCT and Self-Efficacy Theory share a close relationship, as self-efficacy is a central construct in both theories. SCT proposes that self-efficacy is a key factor in shaping behaviour, as individuals are more likely to engage in behaviours they believe they can successfully perform. Self-Efficacy Theory takes this a step further, focusing specifically on the role of self-efficacy beliefs in shaping behaviour and proposing that self-efficacy can be enhanced through mastery experiences, social modelling, and other factors.

Overall, while SCT, TPB, Maslow's Hierarchy of Needs Theory, and Self-Efficacy Theory all consider the role of cognitive and motivational factors in shaping behaviour, they differ in their specific approach and the constructs they emphasize. However, they can all be useful in understanding and predicting individual behaviour in different contexts.

3.6 Theoretical Framework

According to LaMorte(2019), the theoretical framework is a structure that supports the theory that explains why the research problem that studying exists. It encompasses concepts, definitions, existing theories, and other literature that researcher have referred in the study. The theoretical framework demonstrates the understanding of the concepts related to the research paper and the broader topic (Wame, 2019).

The selected theory becoming philosophical reasoning to ascertain academic philosophical position and also able to underlying factors of any enquiry about the research. The Social Cognitive Learning Theory acknowledges the constant interaction that exists between the individual and his or her environment, both structural and social, to shape behavior (Bandura, 1986). Cluster of theory are from Sociology which is extension version of SLT by Bandura in 1977. This theory become foundation of research whereby its serves as foundation when the research were constructed. It also support by LaMorte (2019) where fundamental of theory are considers the unique way in which individuals acquire and maintain behaviour, while also considering the social environment in which individuals perform the behavior. It's also started learning occurs in a social context with a dynamic and reciprocal interaction of the person, environment, and behaviour. Wame (2019) stated many theories of behaviour used in health promotion do not consider maintenance of behaviour, but rather focus on initiating behaviour. This is unfortunate as maintenance of behaviour, and not just initiation of behaviour, is the true goal in public health. The goal of SCT is to explain how people regulate their behaviour through control and reinforcement to achieve goal-directed behaviour that can be maintained over time.



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3.7 Analysis of Findings - Conceptual Framework

A conceptual framework is a written or visual representation of an expected relationship between variables. Variables are simply the characteristics or properties that you want to study. The conceptual framework is generally developed based on a literature review of existing studies and theories about the topic. There are three sources for a conceptual framework: (1) experience, (2) literature, and (3) theory. Refer to the Figure 3.6, conceptual framework has been develop based on systematic literature review by identified the related variable, contract or axiom. This framework are anchored by social cognitive theory introduced by Bandura 1985 which is part of sociology theories. There are 3 main variable employ from the theory which is Environment, Personal and Behavioral. Refer to above findings there are a few variable has been identified that significant to the theory. Independent variable is behavioural whereby dependent variable are environment factor which support by sub variable of Indoor Air Quality. Both variable were interconnect by mediating variable which is personal factor. Any value change in contributing independent variable will directly proportionate toward dependent variable. In meantime.

After identified the variable and mapping the literature review, main concept has been establish within output of literature review and any other related source. Process of deconstructing and categorizing the concept to the main attribute also required good strategy in literature review. Meanwhile, it's also manage to identify a few problem statement that that required to be resolve by the end of the study. Through this process, researcher manage to identify the knowledge gap in population, concept, perspective & implication. It is also uphold ontological assumption which is there no IAQ model on board Warship.

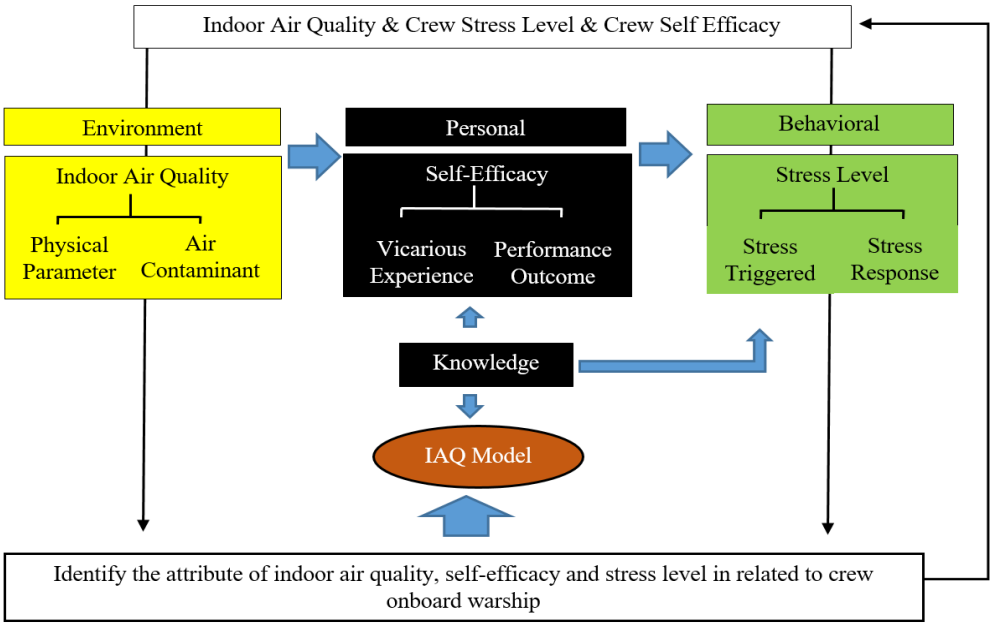

Figure 3.7 Conceptual Framework

This conceptual framework also portray a good argument toward importance and contribution of the study which is to provide better understanding and valuable information on how indoor air quality affect stress level of the crew. It is also identified the contribution of the study as outcome of the research will be Warship Indoor Air Quality Model which may implement by management of warship. This framework also able generate the research problem, research question, method of data collection, method of data analysis, findings and interpretation.

Conclusion

In conclusion, IAQ on board a warship is an essential factor that can impact the stress levels and overall wellbeing of personnel. Poor IAQ can exacerbate the stressors associated with a warship's unique environment and contribute to psychological distress. Effective IAQ management strategies can mitigate the negative effects of poor IAQ and improve the overall health and wellbeing of crew members. By prioritizing IAQ management, warships can maintain a healthy and productive environment for their personnel. Research model, promulgate conceptual framework are feasible to formulate the model of the study on key findings validate from previous research by theory testing. It also support philosophical stance toward research design strategy and able to describe the overall process. It's manage to underline the preparation based on issues derived from the framework relating to the existing theory. Thus, this framework will be root items in determine research method through research design process and able to provide the research design strategy where judgment are based.

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