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## **Eastern University**

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An Article should be research based and demonstrate the author's own analysis and judgment. It must be an original work and not sent for publication elsewhere. Every article should begin with an abstract of about 250 words.

Book reviews are also considered for publication and they should be within 1500 words (Excluding Reference).

All articles submitted for publication in the journal should be printed, double-spaced on one side of A4 papers with ample margin (an inch and a half on the left-hand side and one inch on the top, bottom and right sides). Their hard copies should be sent in duplicate together with a soft copy in Microsoft Word. The author(s) will be informed of the status of the article at the end of the peer review process, which may take a while. The author of an accepted article may be asked to make revisions if required. Manuscripts not accepted for publication are not returned. The authors will receive two copies of the journal that carries the article. Book reviewers will receive one copy of the journal.

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Example: Arrangers, order fulfillers, assemblers & customizers, etc. are also important specialized service providers (Bowersox and Cooper, 2001).

- However, when something is quoted from a source, the exact page number must be provided in addition to above information.  
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# Abortion under International Law and *Shari'ah*: A Brief Comparison

Anowar Zahid<sup>1</sup>

## Abstract

*Abortion is a denial of the right to life, which is the most important of all human rights because the enjoyment of other rights depends on the existence of life. Hence, national and international laws provide for the protection of this right. However, there may be circumstances in which abortion is unavoidable. For this reason, abortion should neither be freely allowed nor should it be totally denied. This paper would moot and test this proposition under international law and Islamic law from a comparative perspective.*

**Keywords:** Abortion, Right to Life, Unborn Child, Fetus, Islamic Law/*Shari'ah*.

**Acknowledgement:** This research is funded by Eastern University

## 1. Introduction

Abortion is lately being advocated by some human rights advocates, especially some non-governmental organizations (NGOs) like Center for Reproductive Rights (Tozzi, 2010), as a right of women even though there is no clear provision in favor of it under any treaty or customary international law. The purpose of this paper is to review the position of this issue under international law and *Shari'ah* law (Islamic law) from a comparative perspective. The reason behind this study is that while research has been done in international law of abortion such as Tozzi (2010), no work has been there to compare it with *Shari'ah* law, whereas it is a source of law in many countries (especially Muslim majority countries). Besides, it is international in nature as it applies across the

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border between Muslims because of the unity of faith and, between Muslims and non-Muslims by choice, such as in business transactions. Readers interested in human rights, international law and Islamic law may find this paper relevant to read.

## **2. Abortion under International Law**

### **2.1 International Conventions**

Since abortion involves killing of the fetus (after it has received soul) in the mother's womb, it may be considered a crime of murder, which is against the human right to life. For example, Article 1 of the *Universal Declaration of Human Rights (UDHR) 1948* says, "Everyone has the right to *life, liberty and security of person*" (UDHR, 1948) (emphasis added) (Brownlie, 1981). This provision indicates that anyone who has life is entitled to its protection. An unborn child, after getting life, comes under this provision. It may be mentioned that the UDHR is not a treaty and as such not binding on nations. However, it has, through practice of states, attained customary law status (Hannum, 1995/1996). So, its provisions relating to life is of count for the protection of the unborn.

Now, attention may be paid to the *International Covenant on Civil and Political Rights, 1966*. Article 6 Paragraph 1 of this convention reads, "Every human being has the inherent right to life. This right shall be protected by law. *No one shall be arbitrarily deprived of his life*" (emphasis added) (Brownlie, 1981). And Paragraph 5 of the same Article states that "Sentence of death shall not be imposed for crimes committed by persons below eighteen years of age and *shall not be carried out on pregnant women*" (emphasis added) (Brownlie, 1981). The expression, "every human being" should include, among others, an unborn child after it has received the soul. And this child is an innocent person. Killing it may be considered as an arbitrary deprivation of life (Tozzi, 2010). This is a clear violation of the above provisions. Besides, this goes against the objective of the Covenant as enunciated in its Preamble- "to promote universal respect for, and observance of, human rights and freedoms"- a reiteration of the states' obligations under the *United Nations Charter*.

Next is the *Convention on the Rights of the Child, 1989*. Article 6 Paragraph 1 provides for the state parties' recognition of the inherent right to life for every child. Paragraph 2 of the same article imposes an obligation on them to "ensure to the maximum extent possible the survival

and development of the *child*”(emphasis added). Now, what does the term, “child” mean in this context? Is it only a child who is born? Does it include an unborn child as well? Here, the rules of interpretation of treaty as contained in Article 31 of the *Vienna Convention of the Law of Treaty* are relevant. This article requires the interpreters to give “ordinary meaning” to the terms used in a treaty “in their context and in light of its object and purpose.” Now, the question is- what is the ordinary meaning of child in the present context? The pre-birth stage is precedent to the birth of a child. Without the former the latter cannot be imagined. This reality is the context here, which requires the protection of the child both at the pre-birth and post-birth stage. Protection at the pre-birth stage is especially important if the fetus has received life. This may be argued to be the contextual meaning of the child under the Child Convention. In addition, the term may be interpreted in light of the object and purpose of the Convention. In this respect, the Preamble of the Convention is relevant, which says that the Convention was adopted “(b)earing in mind”, among other things, that ...“the child, by reason of his physical and mental immaturity, needs special safeguards and care, including appropriate legal protection, *before* as well as after birth” (emphasis added). This also underlines the fact that drafters of the Convention had both the unborn and born child in their mind to extend it the benefits of the Convention. As such, it may be safely concluded that the Child Convention in question recognizes the life of the fetus side by side of that of the born child and creates obligations for the state parties for its survival, development and protection.

## **2.2 Customary International Law**

Customary international law develops through repeated and consistent practices of states. Such practices (objective) should be backed up by another psychological element, i.e. opinion juris – states feel legally obligated to follow it. Thus, state practices have these two characteristics to reach the status of “custom”, hence customary international law. It is simply a “constant and uniform usage, accepted as law” (as cited in Harris 2010, p. 19). The sources of international customs are (i) texts of international instruments, (ii) decisions of international court, (iii) decisions of national courts, (iv) national legislation, (v) diplomatic correspondence, (vi) opinions of national legal advisers, and (vii) practice of international organizations (ILC, 1950). Obligations under this law are not explicitly created as in the treaty-based laws. Such obligations arise

from their voluntary reception by states. If any state does not want to bind itself by a practice, it may persistently make protest against it (Oppenheim, 1955). With regard to abortion, there is no customary practice. Sixty-eight states of the world clearly prohibit abortion. They allow abortion only in the extreme case of saving mother's life (Tozzi, 2010). For example, Malaysia criminalizes the act of abortion with punishment of imprisonment for ten years or fine or both unless it is done to save the mother's life (*Penal Code*, s. 315). Thirty-five states allow it only for the physical health of the mother, while 37 states have limitation of a varying degree on abortion. And only 56 states are debatably claimed to allow abortion without any such restrictions (Tozzi, 2010). Thus, an overwhelming majority of states' practice is against abortion. In other words, no-abortion can be said to be the international customary practice.

### **3. Abortion under *Shari'ah* (Islamic Law)**

#### **3.1 Theoretical Approach**

The present issue would be approached from the theory of *Maqasid al-Shari'ah* (Objectives of *Shari'ah*). According to this theory, law is made in consideration of the purposes for which Allah (God) has revealed the *Shari'ah*. The purposes in question are to bring benefits to humans and to remove their harms as the Holy Qur'an says, "Allah wants ease and comfort for you; He does not want hardship for you" (Al-Qur'an, 2:185, <https://corpus.quran.com/>). As such, *Shari'ah* aims to attain these purposes in the lawmaking process and classifies them into three categories: essentials (*daruriyyat*), complements (*hajiyyat*) and desirables (*tahsiniyyat*), which are briefly described below.

**Essentials:** This category includes mainly five major interests, namely religion, life, human intellect, family lineage and material wealth. It also includes, among others, the followings: fulfillment of contracts, preservation of the ties of kinships, honoring the rights of one's neighbors, social welfare support, freedom, human dignity, human fraternity, protection of fundamental rights, and freedoms, economic development, Research & Development (R&D) in technology and science, peaceful coexistence among nations, and love of God, sincerity, trustworthiness, and moral purity (Kamali 2008).

**Complements:** This class of objectives includes concessions granted to the *hukm* (commands) of the Lawgiver (Allah) in exceptional time and

situation in order to keep the Essentials up. For example, praying five times obligatory prayers is an Essential. No Muslim is allowed to give up this *hukm*, but is allowed to enjoy concession. Thus, a traveling Muslim is required to shorten the units (*rakat*) of obligatory prayers. This “concession” is to help him/her to obey the command of Allah. In other words, it facilitates a believer to fulfill the Essential of the religion.

**Desirables:** The third type of interests entails optional and supererogatory duties, which contributes to the fulfillment of Essentials. While Complements help one meet the Essentials by granting concession to a *hukm* in the face of difficulty, Desirables help one to attain the same goal by way of encouragement to do good. For example, Prophet Muhammad (peace be upon him) encouraged the Muslims to make optional charity (*sadaqah*), even if it is half a date (<https://sunnah.com/bukhari:1417>). The whole purpose is to make them ready, through creating a habit of spending on others, to pay *zakat*, which is an Essential of the religion.

As noticed above, there are five main Essentials. Life is one of them. It is so because Allah created humans to worship Him. To quote the Qur’an, “I (Allah) have created Humans and Jinns only for My worship” (Al-Qur’an, 51:56, <https://corpus.quran.com/>). In order to uphold this purpose of creation, *Shari’ah* attaches utmost value to human life and declares killing life a major sin. Killing humans without a lawful reason is so sinful that the Qur’an equates the killing of a single person with the killing of the whole human nation. And saving life is so virtuous that saving one single life is tantamount to saving of the whole mankind (Al-Qur’an, 5:32, <https://corpus.quran.com/>). Therefore, punishment for murder is killing of the killer unless the victim’s family forgives the convict by or without taking blood money:

And do not kill anyone, which Allâh has forbidden, unless there is a just cause. And whoever is killed wrongfully (not by mistake), We have given his next-of-kin the authority (to take the killer’s life through due process of law or to take blood money or to forgive). But let him not exceed limits in the matter of retaliation. Surely he shall be helped (Al-Quran, 17:33, <https://corpus.quran.com/>).

In addition to the physical protection, *Shari'ah* provides for the economic and social protection of life. In the words of Prophet Muhammad (peace be upon him). "There is no right for the son of Adam in other than these things: A house which he lives in, a garment which covers his nakedness, and Jilf (a piece of bread) and water" (<https://sunnah.com/tirmidhi:2341>). Thus, Islam imposes obligations on parents for the upbringing of their children and on (adult and capable) children for parents and poor relatives. The ultimate responsibility is, of course, of the Islamic state to take care of the citizens as understood from the saying of the Prophet, "Everyone is a keeper unto every other and responsible for the welfare of all" (as cited in Syed, n.d.).

### **3.2 Putting the Theory into Practice**

Now, what is the position of abortion under Islamic law? As mentioned above, Allah creates life for the purpose of His worship alone. So, killing this life without any just cause (such as for punishment of intentional murder) is prohibited. A relevant question in this respect is- when does life come into existence? Prophet Muhammad (peace be upon him) answers this question as follows:

(As regards your creation), every one of you is collected in the womb of his mother for the first forty days, and then he becomes a clot for another forty days, and then a piece of flesh for another forty days. Then Allah sends an angel to write four items: He writes his deeds, time of his death, means of his livelihood, and whether he will be wretched or blessed (in religion). Then the soul is breathed into his body....  
(<https://sunnah.com/bukhari:3332>)

As understood, after four months (120 days) of conception, the human embryo receives soul and turns into a fetus. Islamic jurisprudence considers this as a person that possesses rights, even though it cannot hold obligations or liabilities. In this sense, its legal capacity is defective (Rahim, 1911). The first right it has is definitely is the right to its own life. So, killing this life before birth or after birth is not allowed. It is a great sin and crime. This is the consensus (*Ijma'*) of all four Sunni schools of Islamic jurisprudence, namely Hanafi, Maliki, Shafii'i, and Hanbali Schools (Bhala, 2006). Now, how is it about a circumstance where the life

of the mother is critical and cannot be saved without the sacrifice of the fetus even though it has received life? In this case, according to the above theory, an exception (Complement) is to be made to the Essential of life. In other words, abortion will be allowed. Now, a further question may arise- why of the two lives- mother's and fetus' lives- the latter is to be sacrificed? To answer, here the principle of choosing the lesser of two harms will apply. Mother's life is more important than that of the unborn child in that "the mother is the origin of the fetus; moreover, her life is well established with duties and responsibilities, and she is also a pillar of the family. It would not be possible to sacrifice her life for the life of a fetus which has not yet acquired a personality and which has no responsibilities or obligations to fulfill" (Al-Qaradawi, 2004).

Another question may arise as to whether abortion is allowed before 120 days of pregnancy when the fetus has not owned life yet. Islamic jurists permit abortion during this period for varying reasons. Over the reasons there is no unanimity. However, the prominent permissible reasons for abortion agreed upon by the sweeping majority of Islamic scholars are the followings: the physical and psychological health of the mother, pregnancy caused by rape, mother's inability to rear a child due to serious psychological illness (Bhala, 2006). If there is no threat to the mother's life, let alone abortion, even adopting family planning for not taking babies in fear of poverty is not also allowed (State Mufti, 1996). To quote the Qur'an, "And slay not your children fearing poverty, We shall provide for them and for you" (Al-Qur'an, 17:31, <https://corpus.quran.com/>).

#### **4. Conclusion**

Abortion is against the fundamental right to life both under international law and Islamic law. Any attempt by any quarter to advocate for it as a human right, as some NGOs are doing, should be disapproved by all concerned with human rights. At the same, abortion should not be taken as a totally forbidden phenomenon. The right approach would be to take a middle way, that is, when mother's life in danger, then the abortion is allowed as the last resort. This is the common stand of both Islamic law and international law.



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# A Study of Learner Motivation at the Tertiary Level

Iffat Ara Nasreen Majid<sup>1</sup>

## Abstract

*This article presents results of a study that was carried out on a cross section of students of a private university in Bangladesh to find out the factors that motivate the learners and the ones that de-motivate them in their studies. The questions were set on the principles of some basic theories of learning viz. behaviorism, cognitivism and social theories of learning. The results provide an interesting insight into the nature of factors that work as motivators and de-motivators.*

**Key words:** Learner; Motivation; Demotivation, Factors of Motivation/Demotivation, Tertiary Level of Education

## 1. Introduction

A common cause of concern in all educational institutions is the matter of student motivation. The question is not only what motivates learners to study but also what keeps their motivation alive. At the tertiary level especially, this concern becomes more pronounced as learners enjoy a greater independence from parental and institutional control than in their high school days and therefore need to be really motivated to do well and continue with their studies. This study therefore focuses on learners who are in the early years of their tertiary education and tries to identify factors that work as motivators or de-motivators for them. Before introducing the study however, it would be useful to look at some important areas in learning theories that could explain the potential sources of motivation for the learners.

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## **2. A Discussion of Some Major Theories of Learning and Their Views on How Learners Learn**

Language learning has evolved through a series of approaches that look at the learner from different perspectives in order to ascertain what can make learning most effective. The earliest of the learning theories, with origin in behaviorism, are based on experiments in classical conditioning in psychology in the 1930's. The behaviorists focus on the importance of *reinforcement* in motivating learners to learn. In simplest terms, it claimed that learning is encouraged when an action is followed by positive reinforcement i.e. encouraged when it is appreciated and discouraged when it gets negative feedback or negative reaction. Although a number of other claims of behaviorism have been refuted, the concept of reinforcement has stood its ground (Walker & Shea, 1999; Wielkiewicz, 1995). Positive reinforcement in case of learning can take different forms like a smile of approval, good grades etc. Negative reinforcement could range from a light admonishment for bad grades, or even disregard by the teacher. However, positive reinforcement also needs to be at the appropriate level. An investigation by Majid (2011) actually found learners complaining that they are being treated as kids or teachers have been showing condescending attitude. The main focus of behaviorism is therefore appropriate reward or punishment to enhance motivation in the right kind of learning.

The approach that considers the learner as a whole is that of humanism (Slavin, 2012). It takes into cognizance how learners view their life experiences in relation to their growth as a human being. Their motivation for learning would depend on how much they feel the institution is contributing to their personal growth. The things that are important for learner motivation in humanism are

- contribution of the lessons;
- student teacher relationship
- the classroom environment.

An essential factor of humanism is the ability of the teachers towards uplifting the learners' emotional as well as intellectual condition by bridging the gap between what they know to assessing where the learners

stand at a certain point of time intellectually and starting from there. A large-scale investigation by Guillotteaux and Dornyei (2008) on more than 1300 learners of 40 ESOL classrooms and 27 teachers in South Korea found that the “motivational practice” of language teachers was linked to the state of motivation of the learners and an increased level of “motivated learning behaviour” of the learners.

Social learning, on the other hand, focuses on the classroom activities themselves and states that a learner will be motivated to learn depending on:

- how much they expect to succeed on the task
- how much they value achievement on the task.

The concept of self-efficacy is an important element in this approach. It refers to a learner’s perception of their ability to accomplish a task. Bandura (1997) identifies four phenomena that affect self-efficacy:

1. Mastery experiences: these refer to one's personal experience with success or failure.
2. Vicarious experiences: these refer to learning by observing the experiences of others.
3. Verbal persuasions: these refer to motivating learners by using verbal feedback to convince or encourage them to accomplish their tasks.
4. Physiological state: Symptoms like anxiety, nervousness, rapid heart rate, sweating etc. often occur when learners face challenges that require competence to overcome. Such physical or mental states reflect learner perceptions of their self-efficacy; which in turn affect their performance.

A learner who believes s/he has the ability to succeed will persist on trying despite facing difficulties. If two learners with the same level of ability are compared, the one with the more positive view of self-efficacy will be more confident to tackle the task in the face of challenges. However the sense of self-efficacy is supported by the fact that the task in question would support genuine progress for a worthwhile goal. The usefulness of the task for a worthwhile cause contributing to personal growth and the belief in the ability to be able to tackle the task are important elements in

the humanistic approach to learning. The role of the teacher here again becomes a vital one in supporting or minimizing a learner's level of confidence. Fencle and Scheele (2005) observes in their study: "It is particularly exciting to note that teaching strategies used in the classroom can and do make a difference to students' self-efficacy".

**Cognitive learning** approach, on the other hand, tries to explain learning from a more intellectual point of view by claiming that people get interested to learn because of an inherent urge to understand "the way the world works." This tendency is inherent by the fact that even a toddler would turn a toy upside down and stare at the wheels to understand how they move. Learning in this case has to be connected to our existing schema- to the knowledge of things that we have about the relationship of things and how they work in this world. It is important that

- a learner be faced with challenging questions that encourage them to explore their existing schemata;

- explain reasons for the topics being studied, so that the learners can relate them to particular areas of learning and understand how it will help improve their perception of things (Bandura,1993);

A study by Killen (1994) on factors that influence academic success or failure of first-year and senior university students concludes that some of the most "significant factors in students' academic success at university were interest in the course, motivation, self-discipline and effort (none of which can be predicted directly from matriculation results)" (p. 209).

An important aspect of the approaches discussed so far is that they reveal two sources of motivation-

- intrinsic i.e. emerging from inside a learner
- extrinsic i.e. triggered by some external reason.

These types of motivation are triggered by different kind of behaviours, which are evident in the literature review that follows.

A study by Stan (2012) on the role of grades in motivating students finds that for a majority of students duty towards parents was a stronger

motivation for the teenage learners than good grades. They reported that 28% of teachers in their study were of the opinion that grades actually demotivated the learners.

Puchta (2006) finds that classrooms help acquire social skills by developing:

- The skill of empathy (the ability to place oneself in another person's shoes and thus understand others better);
- The ability to see and understand your own behavior and to adapt and change it in constructive ways;
- The growing awareness of one's own emotional processes and one's own ability to handle and understand feeling in a better way.

This opinion of Puchta is corroborated by the findings of Meyer and Turner (2002). Their study on the role of emotion in classroom motivation reveals that although cognitive support is necessary it is not sufficient enough for learning experiences to evoke student involvement. They find that emotions are integral for understanding the learners' goals as well as how they make class projects personally relevant and also to maintain their well-being. According to their findings, teachers with positive emotions towards learning are important to create similar emotions in the learners as well. Teacher classroom behaviors that are considered positive comprise of encouragement in interpersonal interactions, jokes or laughter whereas negative behaviors comprise of scolding, sarcasm and humiliation.

A study by Yusuf (2011) on the impact of achievement motivation, self-efficacy and regulated learning strategies conducted on 100 undergraduate students in Malaysia finds that there is a direct effect of self- efficacy and an indirect effect of self- learning strategies and achievement motivation on the academic accomplishments of the participants. Motivation is thus affected by both direct and indirect sources. The relationship of rewards for motivations is also studied by Peirce *et al.* (2003) in an experiment conducted on 60 undergraduate university students half of whom were paid for correct responses and half of them without any reward found the group with rewards performing with more enthusiasm than those without reward and concludes that rewards can be used positively to increase students' intrinsic motivation.

### 3. The Study

To investigate the factors that affect learner motivation at the tertiary level in Bangladesh a study was conducted on 50 students of a private university with learners chosen randomly (random sampling) from four disciplines, viz. Business Studies, Science and Engineering, Law and Arts.

The research questions to be investigated are:

- 1) What factors *motivate* learners to study at the tertiary level?
- 2) What factors *de-motivate* learners from studying at the tertiary level?

#### 3.1. Methodology

Data was collected mainly through a questionnaire with a combination of both closed and open questions that were expected to provide insight into both intrinsic and extrinsic motivation. For the purpose of triangulation, an FGD of 5 students (1 from each discipline selected through purposive sampling) was held. Five teachers (1 teacher from each discipline) selected through purposive sampling, were also interviewed. The interviews were semi-structured so that additional information could be sought wherever needed.

#### 3.2. Findings and Discussion

In this section, the findings of the study are being presented and discussed.

##### 3.2.1. The Survey

The results of the survey are presented in the tables that follow. As mentioned before, the questionnaire consisted of both closed and open ended questions. Table 1 presents results of the closed questions in percentage.

**Table 1: Frequency of responses of learners regarding what they find motivating in a course**

N=50



<b>Motivating factors</b>	<b>Very important</b>	<b>important</b>	<b>Not important</b>	<b>No response</b>
Good grades in that course	31 (62%)	10 (20%)	7 (14%)	2
I feel it will be useful for me	25 (50%)	19 (38%)	4 (8%)	2
When I find it difficult (challenging)	11 (22%)	20 (40%)	15 (30%)	4
When I find it easy	15 (30%)	17 (34%)	18 (36%)	0
When I have enough reading materials on the topic	17 (34%)	18 (36%)	13 (26%)	2
When the teacher explains in an interesting way	35 (70%)	11 (22%)	4 (8%)	0
When I find my friends taking interest in it	11 (22%)	16 (32%)	19 (38%)	4
When the course teacher is friendly	32 (64%)	10 (20%)	6 (12%)	2

Table 1 reveals that the learners value interesting presentations by the teachers as the most important factor to draw them to their classes, as expressed by 70% of respondents. An additional 22% consider it an important factor for motivating them which means that for (70%+22%) 92% of learners, it is an important factor. Friendliness of the teacher is also valued highly where we get a total count of (64% +20%) 84% of learners for whom it is important. Compared to this, we find influence of friends of much less importance, although it cannot be ruled out altogether. It appears from the table that teachers have the highest influence in motivating learners and retaining their interest in the class. The next important category is of good grades, which 62% of learners

consider very important and an additional 20% consider important. This factor will be discussed in more detail in table 4. A challenging course also drives learners to strive harder for that course as evident by the responses of (22%+40%) 62% of learners but for 30% a course that is easier to understand is more motivating. However, for 36% of learners, this is not so important, which implies that these learners prefer courses to be challenging rather than easy (which probably make them strive harder and thereby attain cognitive success). Having sufficient reading materials for studying are important motivators for (34%+36%) 70% of learners. This is an important indicator for educators to ensure that learners have access to sufficient study materials to retain their interest in the subject. This information is further supported by the next table where learners indicate what factors de-motivate them most.

**Table 2: Responses regarding demotivating factors related to the course**

<b>De-motivating factors</b>	<b>Very important</b>	<b>important</b>	<b>Not important</b>	<b>No response</b>
Bad grades in that course	14 (28%)	4 (8%)	30 (60%)	2
Course difficult to understand	17 (34%)	21 (42%)	12 (24%)	0
Dislike the teacher	16 (32%)	12 (24%)	22 (44%)	0
Too much pressure of syllabus	10 (20%)	24 (48%)	16 (32%)	0
Inconvenient class timing	15 (30%)	13 (26%)	22 (44%)	0
Insufficient study materials	18 (36%)	18 (36%)	14 (28%)	0

In table 2, we find that (36%+ 36%) 72% of learners consider not having sufficient study material as important de-motivators. The next most important factor is the difficulty in understanding the course which is important for (34%+42%) 76% of learners. This category is different from courses being challenging by the fact that a challenging course would be intellectually gratifying because it gives a learner a sense of achievement, but for a course that is difficult to understand a learner would feel de-motivated because there is an element of failing to cope

with it intellectually/cognitively and producing a sense of negative self-efficacy. Hence this information bears out the fact that positive self-efficacy is an important factor for learner motivation. Inconvenient class timing has been considered important by (30%+26%) 56% of learners. However, *it would be worthwhile investigating further why class timing should be inconvenient for learners.* Attitude towards the teacher comes up as an important factor as it becomes a de-motivator for (32%+24%) 56% of learners when they dislike their teacher. However, for the rest of 44%, other things are more important. Too much pressure of syllabus has been considered important as a negative factor by (20%+48%) 68% of learners, which implies that they are unable to cope with the pressure.

So far factors that are directly related to the classroom and teaching have been discussed. However, other factors can be equally important in affecting learner motivation *indirectly*. The following table reveals student feedback on some of these factors. It can be mentioned in this respect that the categories that have been given in the section of “Nature of problem” actually emerged from those mentioned in the open ended section of the questionnaire where students were asked to mention the kinds of problems that they face that hinder their concentration on their studies or affect their level of motivation.

**Table 3: Factors that distract learners from studies**

<b>Nature of problem</b> <i>(categories that emerged through the open ended questions)</i>	<b>Frequency of responses</b> <b>(n = 50)</b>
Financial problems	21 (42%)
Too much time spent with friends	9 (18%)
Problems of traveling from residence	14 (28%)
Too much involvement in extra-curricular activities	12 (24%)
The feeling that choice of subject was wrong	10 (20%)
Family problems	17 (34%)

Table 3 sums up and classifies the nature of factors that distract learners from their studies. It was found that the majority (42%) of the students

found financial problems distracting for them. The next category was problems related to the family which was mentioned by 17 (34%) students. Travelling from residence was an important factor for 14 (28%) students. However, 10 students felt that their choice of subject was wrong, which meant that they were disappointed with what they were studying. 12 students felt that they had somehow become too much involved with their extra-curricular activities that were keeping them away from their studies. It is interesting to note that for some (9) students spending time with friends was becoming an impediment to their studies rather than helpful.

**Table 4: A comparative description of the effect of grades**

<b>Effect of grades</b>	<b>Very important</b>	<b>important</b>	<b>Not important</b>	<b>Both are important</b>	<b>None are important</b>
Good grades as motivators	30 (60%)	11 (22%)	6 (12%)	19 (38%)	5 (10%)
Bad grades as de-motivators	14 (28%)	4 (8%)	30 (60%)		

Students were asked exclusively to comment on what they thought was the role of grades in motivating them. Table 4 shows that 60% of students considered good grades very important while for 22% it was important. Thus, (60%+22%) 82% considered it important as a motivator. However, interestingly for 6% of learners, it was not important at all. 60% of students did not consider bad grades as de-motivators. However, for (14% +4%) 18% of learners, bad grading was a demotivating factor. Most interestingly, for 5% of learners grades (good or bad) are not important at all, while for 38% of learners both are important.

The FGD of the learners and interviews of the teachers shed further light on the issues raised in the survey and will be discussed in the next sections.

### 3.2.2. The FGD

The FGD with the students was very informative. It helped to provide an insight into the nature of some of the major problems that Bangladeshi learners face at the tertiary level. The details of the FGD are given below.

Q: Are good grades important?

A: *“During the first semester if for any reason grades drop in a particular subject I get demotivated about studying that subject.”*

Passing the exams somehow was the main goal of such students even if their grades dropped. However, some of them were of a different opinion:

*“Bad grades in mid-semester exams actually can be motivating also. I study harder to make up the marks”*

But that was not the case with everyone as it is obvious from the previous comment.

Q. What do you think is the most important factor that affects you the most?

A: *“The nature of the course. If I find it easy to understand, I will pay attention to it. Otherwise, I will just focus on passing the exams only in that subject. If I find the course difficult I study the slides or the handouts only that was used in the class by the teacher”.*

*“Sometimes I wonder why we are studying a particular topic and how it would be useful for us.”*

Not being able to appreciate the usefulness of a course is actually a strong demotivating factor

Q. Do you face any financial problems?

Financial problems were an issue with those students who did not live with their families in the city.

A: *"I have to live in rented accommodation with some other class mates to save expenses".*

*"Many of us have to do part-time work to meet our expenses."  
"Private tuition is the most common option for most of us. The problem is that we do not get sufficient time for our studies, so we don't get good marks".*

*"Some of our friends actually just attend the classes as class attendance is counted but study only before the exams",.*

Q. What about students who live with their families?

A: *"I live with my family but coming to the university in time for classes is a big problem as some of us travel long distances and get stuck in traffic jam. Early morning classes become very difficult to attend, I get late most of the time."*

Q. How much time do you spend chatting with your friends?

A: *"That is something we can't do much. We used to chat more in the first semester but after the first semester there is very little time only a short time between classes or if a class is cancelled".*

Q. Do you like doing extra-curricular activities like joining debating clubs, cultural clubs, language clubs etc.?

A: *"Yes, I like debating. It helps improve my speaking ability. I like it but I don't have much time".*

*"I am not much interested but my friend is. But he keeps running. It consumes much time"*

Although some were not interested at all, those who liked extra-curricular activities were of the opinion that these helped to develop their abilities as a person and would be more useful in performing better in jobs or dealing with people.

The above mentioned observations made by the students reveal that great deal of student performance is affected by issues not quite academic in nature. Financial problems, working to meet expenses, travelling long distances take up their valuable study time. However, issues like boring classes or not comprehending the lesson or lack of interest in the lesson are issues that can actually be addressed by course teachers and mitigated. Explaining the relevance of a course for the curriculum and its future usefulness could actually help learners take more interest in the lesson and work towards increasing their motivation to attend the classes. Teachers also need to get in touch with students achieving low grades and find out what is affecting their performance as learners.

The opinions of the learners also emphasize the need for teachers to constantly evaluate the conceptual understanding of their learners and adjust their teaching to the level of their learners for a positive impact.

### **3.2.3. Teacher Interviews**

The interviews of the teachers regarding what motivates or demotivates the learners, on the other hand, give a somewhat different picture, as presented below:

Q. Are good grades important?

A: *Only good students are interested in good grades. If their grade is not according to their expectation they come to the teachers to find out the reasons. Also if their marks are lower than their friends', then that also could become a demotivating factor.*

Q. What is the most demotivating factor for the students in your opinion?

A: *“Not being able to understand their subject”.*

When asked how they could understand that their learners did not comprehend what they teach, some teachers said that they could read their confused looks and adjust their teaching. However, they felt that some teachers were not in the habit of doing so and blame the learners for not being attentive enough.

Q. Do you try to explain to the students how each topic is related to the overall curriculum?

A: *“Well, the students should understand. If they ask for such nexus, I explain, but normally the lesson takes up a lot of time”. “Yes, it would be beneficial, if they understand the utility of the topics taught”.*

*The best way to involve the learners is to get them to do presentations in the classroom. Presentations also have both negative and positive aspects”. “the good students find presentations motivating but the weak students find it challenging and face threatening.*

Not all the teachers were sure that they made it a point to relate every topic to the overall curriculum. However they agreed that it was a useful practice.

Q. Do most students attend classes regularly?

A: *“It is very important to attend classes regularly. Some learners might have genuine reasons for missing out classes, some are not simply interested in their studies and give lame excuses.”*

Q. How can you help the students with the lessons?

A: *“Slides and handouts are quite useful and also convenient as it helps the learners understand better. It is not always possible to help individual students unless they themselves come to the teachers and ask for help. We are also under a lot of work and time pressure.”*

Q. Do you think that financial pressure hampers their studies?



A: *“Yes. There are many students who need to work to meet their educational expenses but there is very little we can do about that except to keep motivating them to continue with their studies”*

The teachers shared that sometimes they tried to help by advising the learners not to give up their studies and return in the next semester if they have dropped one at all. They also advise the students how to manage the gaps in learning in the event of semester drop. They felt that this had a positive effect in many cases.

One teacher observed that there are some students who are completely indifferent to their studies. They come to class and deliberately go to the last benches and sit through the class without paying much attention. *“Sometimes they are busy with their mobile phones. They students are only interested in the certificate of a degree, or are focused more on preparing for the BCS exams if they are in their last semesters”*...to keep them alert and involved in the class I keep asking them questions. *I target the back benchers in my classes quite often”*.

Q. Do you think that extracurricular activities are useful?

A: Not all teachers were much bothered about learners participating in extracurricular activities, but one teacher was very positive about it and felt that such activities were actually helpful in raising learner self-confidence and self-efficacy.

When we compare the results of the FGD, and the teacher interviews we find that both groups agree that making classes interesting and easy to understand is a very strong motivating factor. However, they differ on how that is to be achieved. The teachers are aware that some students have genuine reasons for not being able to attend to their lessons as supported by the comments of the learners but other teachers seem to need training in making classes more interesting. Grades appear to have both negative and positive impact on the learners' motivation depending on the nature of the learner, a view supported by the results of the survey as well. Issues of self-efficacy become prominent when some learners get bad grades and need reassurance by the teachers that they are capable of doing better. This finding is corroborated by the study by Stan (2012). Good grades also play the role of rewards for some learners as found by Pierce *et al.* (2003) and

can work as intrinsic motivation for some learners. Teachers again could play an important role by advising students who do badly in the mid-course exams as comments of some learners have shown that they could be motivated to perform better to improve on their grades. Reinforcement in the form of teacher attention, and positive attitude can also go a long way in motivating a learner.

The comments of the teacher interviews and the FGD support the views expressed in the students' survey. They show that both teachers and learners feel that motivation of the learners is affected by various sources. These sources are both intrinsic and extrinsic as shown by this study by the interplay of self-efficacy, reinforcement and rewards of different factors that affect the Bangladeshi tertiary level learner. While the extrinsic sources are not so much within a person's control, they certainly have a negative impact on the learners' performance.

#### **4. Conclusion**

The above study was done on a small group of students to find out the factors that motivate or demotivate them at the tertiary level of education in Bangladesh. Although the data were small but it revealed important indicators regarding issues that affect the intrinsic and extrinsic motivation of the learners. Many of the demotivating factors related to teaching could be reduced if the teachers are much more alert both about their teaching and how the learners are reacting to it. Teachers who lack this sensitivity could require training to develop better awareness of the dynamics of teaching. However, there are other issues like traffic jams and family problems that are beyond the control of the teacher or the institution but are humanistic issues that can be addressed by developing friendly relationships between the teachers and the learners. In addition, the teachers may allow the students to retake their exams for the improvement of their grades. As well, they may counsel those who are emotionally disturbed.

Further research in this area could be conducted on a much a larger scale by involving a lot more students from different institutions. A comparative study can also be made to investigate if motivation of the learners varies with the discipline or gender and also the nature and location of the institution.

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# Role of Ultrasound in the Evaluation of Early Complications of Pregnancy

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## Abstract

*The present study was undertaken to establish an ultrasound diagnosis of complications of early pregnancy. A total of 65 patients with symptoms of vaginal bleeding relating to complications of early pregnancy (1<sup>st</sup> trimester of pregnancy) were subjected to an ultrasound examination between March 2017 to August 2017. The cases included were women aged between 18 to 45 years. History taking, physical and pelvic examination were done by the obstetrician. The diagnosis established by ultrasound was classified into three categories as 1) confirmatory, 2) diagnostic and 3) misleading.*

*Of the 65 patients, 43 were found to have such complications by ultrasonography (USG). Out of 43 patients, 7 (16.2%) were found below 20 years of age. The predominant age group for complications to occur was 21 to 30 years. Over 50% of the cases were found in this age group. Only 3 (7%) patients were found between 41 to 50 years who all had complete abortion. Out of 43 patients, 16 had incomplete abortion (37.2%), 10 missed abortion (23.2%), and 8 complete abortion (23.2%). Perisac bleeding, hydatidiform mole, blighted ovum and ectopic pregnancy each comprised of one case (2.32%). The majority (93%) of the cases were of spontaneous abortion. All cases of abortions were reported to occur between the 6th and 12th week's pregnancy with 16 (37.2%) incomplete abortion, 11 missed abortions (25.6%), 9 (22.5%) complete*

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*abortion, and 6 (15%) septic abortion. However, this study is not a reflection of overall incidence and statistics regarding the alignment in our country. For this a more extensive study over a longer period of time covering the different corners of the country is necessary.*

**Keywords:** Pregnancy, Ultrasonogram, Ultrasonography, Ultrasound, Pregnancy, Complication in Early Pregnancy

### **1. Introduction**

Human pregnancy is the most studied of all mammalian pregnancies. The first trimester of pregnancy is an important period often fraught with complications like bleeding and pain, leading to severe apprehension in the mother. Prior to the advent of USG, all these patients were empirically managed only clinically, many times along the wrong line (Iyer and Bhattacharya, 1992).

Ultrasonography, however, has revolutionized the management in such cases of early pregnancy complications so that specific treatment-medical or surgical- can be immediately instituted (Iyer and Bhattacharya, 1992). A sonogram can soothe maternal fears a lot by showing a normal live fetus.

### **2. Materials and Methods**

This study was done on 65 suspected cases of early pregnancy complications (with symptoms relating to complications of early pregnancy) between March 2017 to August 2017. The cases included were aged between 18 to 45 years. The study was undertaken on patients in their first trimester of pregnancy with complications. History taking, physical and pelvic examination were done by the obstetrician. The diagnosis established by the sonographic evaluation was classified into three categories as 1) 'confirmatory' (if the clinical diagnosis was reaffirmed), 2) 'diagnostic' (if the actual status of the patient was established by the ultrasound examination) and 3) 'misleading' (if the

ultrasonographic interpretation did not reveal the actual status of the patient).

### **3. Results**

All patients presented with a history of amenorrhea of 6 to 12 weeks followed by per vaginal bleeding. In 39 (60%) cases, the clinical diagnosis was confirmed using a real-time ultrasonic scanner, in 4 (6.2%) cases the real status was established (diagnostic) and in 22 (33.8%) cases the diagnosis was misleading or not established (Table I). Over half (52.3%) of the cases presented with per vaginal bleeding only, 29 (44.6%) with per vaginal bleeding accompanied by mild lower abdominal pain, 18 (27.7%) with per vaginal bleeding with severe lower abdominal pain and 5 (7.7%) with per vaginal bleeding with excessive vomiting (Table II).

Out of 65 cases studied, 43 (66.1%) cases were confirmed (by ultrasound) to be with complications resulting from early pregnancy. Of them, 7 (16.2%) patients were found below 20 years of age. The predominant age group for complications to occur was 21 to 30 years. Over 50% of the cases were found in this age group. Only 3 (7%) patients were found between 41 to 50 years of age who all had complete abortions (Table III).

Out of 43 patients, 16 had incomplete abortion (37.2%), 10 (23.2%) had missed abortion, 8 (18.6%) had complete abortion, 7 (16.2%) septic abortion. Perisac bleeding, hydatidiform mole, blighted ovum and ectopic pregnancy each comprised of one case only (2.32%) (Table IV).

The majority (40 out 43, 93%) of the cases were of spontaneous abortion. All cases of abortions were reported to occur between the 6th and 12th weeks of pregnancy with 16 (40%) incomplete abortion, 11 (27.5%) missed abortion, 9 (22.5%) complete abortion, 6 (15%) septic abortion (Table V).

**TABLES:**

**Table I: Distribution of patients by diagnostic classification (n =65\*)**

<b>Diagnostic classification</b>	<b>Frequency</b>	<b>Percentage</b>
Confirmatory	39	60.0
Diagnostic	4	6.2
Misleading	22	33.8

**Table II: Distribution of patients by presenting complains (n =65\*)**

<b>Presenting complaints</b>	<b>Frequency</b>	<b>Percentage</b>
P/V bleeding only	34	52.3
P/V bleeding with mild lower abdominal pain.	29	44.6
P/V bleeding with severe lower abdominal pain	18	27.7
P/V bleeding with excessive vomiting	5	7.7

**\*Total will not correspond to 100% for multiple responses**

**Table III: Distribution of patients according to age (n = 43)**

<b>Age (years)</b>	<b>Frequency</b>	<b>Percentage</b>
<20	7	16.2
21-30	22	51.1
31-40	11	25.6
41-50	3	6.9



**Table IV: Distribution of patients according to complications (n =43)**

<b>Name of Complications</b>	<b>Frequency</b>	<b>Percentage</b>
Incomplete abortion	16	37.2
Missed abortion	10	23.2
Complete abortion	7	18.6
Septic abortion	6	16.3
Perisac bleeding	01	2.32
Hydatidiform mole	01	2.32
Blighted ovum	01	2.32
Ectopic pregnancy	01	2.32

**Table V: Distribution of patients by types of spontaneous abortion (n = 40)**

<b>Types of spontaneous abortion</b>	<b>Frequency</b>	<b>Percentage</b>
Incomplete abortion	16	40.0
Missed abortion	9	22.5
Complete abortion	9	22.5
Septic abortion	6	15.0

#### **4. Discussion**

Complications of early pregnancy come to clinical attention when the patients suffering from abnormal per vaginal bleeding with pregnancy. A patient may consult her physician for abnormal bleeding without suspecting that she is pregnant. A urine pregnancy test is usually performed, but a higher rate of false-negative results may obscure the

diagnosis with certainty. The physician may then send the patient for ultra-sonogram to determine the viability and location of the pregnancy.

The majority of spontaneous abortions occur between the 6th and 12<sup>th</sup> weeks of pregnancy. In this study total of 65 patients with symptoms relating to complications of early pregnancy were studied. As shown in our study, the clinical findings were confirmed by USG in only 60% of cases, while in 6.2% of cases it played the diagnostic role. Thus, overall accuracy is 66.2%. These results may be compared with a similar study by Duff (1975) who confirms the clinical findings in only 50% of cases.

43 patients were found to have complications by ultra-sonogram examinations. Complications of early pregnancy were found to be highest between 21 years to 30 years of age group. Out of 43 patients, 22 patients were found in this age group (51.16%). Thus, the 21 -30 years old pregnant women are most at risk of early complications of pregnancy. So, if clinicians or obstetricians encounter a patient with per vaginal bleeding, they may suspect it as a case of early complication of pregnancy unless otherwise proved and should refer the case to an ultrasonologist for a complete evaluation.

Recently, Rajan and Rajan (1987a and 1987b) stated the invaluable role of ultrasonography in first trimester bleeding. A normal pregnancy with excellent chances for a viable birth could be differentiated using USG from a pathological pregnancy, which warrants immediate termination. Also, they reaffirmed the need for ultrasonography in very early pregnancy complications and observed excellent prognosis in over 96% of subjects in whom a normal gestational sac and a live fetus were seen.

The sonographic landmarks of the first trimester pregnancy have been well recognised and they include identification of the gestational sac, fetal pole, fetal cardiac activity, movements, yolk sac and the amnion. The invaluable role of these landmarks, the gestational sac and fetal biometry in diagnosing pathological pregnancies and predicting the pregnancy

outcome has been clearly documented by DeCherney, Romero and Polan (1983).

It appears that USG helps establish the type of pathology in early pregnancy complications. However, a close communication between the sonologist and obstetrician is necessary. The investigation should be viewed as an extension and amplification of the pelvic examination and not the substitute for obstetric history and clinical examination. Besides, this study is not a reflection of overall incidence and statistics regarding the early complications of pregnancy in our country. For this a more extensive multicenter study with a larger sample size is recommended.

### **5. Conclusion**

This study concludes that the role of ultrasound in detecting and evaluating complications of early pregnancy is precise and sensitive and could be reliably used. Moreover, this modality is cheap, non-invasive, radiation free, reliable and allows real-time evaluation of the entire complications of early pregnancy in any plans. As such, an ultrasound was selected as the method of investigation.

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# MHD Natural Convection Analysis in a Rectangular Enclosure with Half-Circular Heated Blocks

Mohammad Abdur Rob,<sup>1</sup> Amena Ferdousi<sup>2</sup> and Murad Hossen<sup>3</sup>

## Abstract:

*In this research, heat transfer phenomenon with MHD natural convection flow in a rectangular enclosure has been investigated numerically via three half-circular heated blocks. The governing equations were evaluated numerically for the streamlines, isothermal lines, average Nusselt number ( $Nu_{av}$ ), average velocity magnitude ( $V_{av}$ ) and average fluid temperature ( $\Theta_{av}$ ) using Galerkin weighted residual finite element method for various Rayleigh, Hartmann and Prandtl numbers. Heated half-circular blocks are situated along the bottom wall of the enclosure. The top wall of the enclosure is kept at a low temperature and the rest of the walls remain adiabatic. Results have been presented for different Rayleigh number ( $10^3 - 10^6$ ), Hartmann number (0 - 40) and Prandtl number (0.10 - 0.98). It is observed that the Rayleigh and the Hartmann numbers have a strong influence on the streamlines and isothermal lines. The significant outcomes on average Nusselt number at the hot half-circular walls for large Rayleigh number ( $Ra > 10^5$ ) and average fluid temperature of the enclosure have been found in this article.*

**Keywords:** Rectangular Enclosure, Natural Convection, MHD, Half-circular Block, Finite Element Method

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## Nomenclature

$B_0$  applied magnetic field strength  
 $C_p$  specific heat at constant pressure  
 $g$  acceleration due to gravity  
 $Ha$  Hartmann number  
 $k$  thermal conductivity of fluid  
 $L$  length of the rectangular enclosure  
 $Nu_{av}$  Nusselt number along the heated rectangular enclosure  
 $p$  pressure of the fluid  
 $P$  non-dimensional pressure of the fluid  
 $Pr$  Prandtl number

## Greek symbols

$\alpha$  thermal diffusivity  
 $\beta$  coefficient of thermal expansion  
 $\theta$  dimensionless temperature  
 $\mu$  dynamic viscosity of the fluid

$Ra$  Rayleigh number  
 $T$  temperature of the fluid  
 $T_c$  cold temperature  
 $T_h$  heated temperature  
 $u, v$  velocity component along x, y-direction  
 $U, V$  dimensionless velocity component  
 $V_{av}$  average velocity magnitude  
 $x, y$  Cartesian coordinates  
 $X, Y$  dimensionless Cartesian coordinate  
 $\theta_{av}$  average fluid temperature

$\nu$  kinematic viscosity of the fluid  
 $\rho$  density of the fluid  
 $\sigma$  electrical conductivity of the fluid

## 1. Introduction

The fundamental problem of natural convection heat transfer in a rectangular enclosure has received a considerable attention from researchers. Various references deal with rectangular enclosures, due to its significance for large-scale natural phenomenon in the fields of astrophysics, geophysics, atmospheric sciences, and a wide range of engineering applications such as cooling of electronic equipment, solidification processes, growing crystals, and solar collectors. Dalal and Das (2006) illuminated on the natural convection in a rectangular cavity heated from below and uniformly cooled from the top and both sides using the finite-volume method in a non-orthogonal body-fitted coordinate system. The authors have observed that the heat transfer has been dominated by conduction across the field layers for  $Ra = 0-10^3$ . Magneto hydrodynamic (MHD) natural convection flow in a square cavity with heated cylindrical block has important industrial applications which have been reported by Zhang *et al.* (2016). Analysis of the flow and heat transfer characteristics for MHD free convection in an enclosure with a heated obstacle for various non-dimensional parameters was examined by Parvin and Nasrin (2011). The authors overlook that the buoyancy-induced vortex in the streamlines is increased and thermal layer near the heated surface becomes thick with increasing  $Ra$  and eddies in the streamlines are reduced and the thermal current surrounding the hot body is thin with elevating  $Ha$ .

Jani *et al.* (2013) investigated MHD free convection in a square cavity and observed that the heat transfer mechanisms, temperature distribution and the flow characteristics inside the cavity depended strongly upon both the strength of the magnetic field and the Rayleigh number. Hossain *et al.* (2015) illuminated on MHD free convection in an open cavity containing heated circular cylinder by finite element analysis based on Galerkin weighted residual approach. The authors establish that for all cases of  $Ha$  and  $Ra$ , the isothermal lines concentrate on the right lower corner of the cavity and there is a recirculation around the

cylinder and one vortex has been created in the flow field. The influence of MHD natural convection flow in a square cavity containing heated enclosure was presented by Rob and Alim (2019). The authors clarify that the area of the rectangular enclosure has a considerable effect on the flow and temperature fields and the vorticity increases with the increment of the area of rectangular enclosure. Jami *et al.* (2008) have found remarkable results on natural convection flow in a square enclosure containing a solid cylinder. Ali *et al.* (2017) investigate MHD free convection flow in a differentially heated square cavity with tilted obstacle and illuminated that the considerable heat transfer enhancement was found for the influence of higher Rayleigh number and lower Hartmann number and the opposite phenomenon are also observed in the case of average temperature.

Rahman *et al* (2010) examined the conjugate effect of joule heating and MHD mixed convection in an obstructed lid-driven square cavity by employing Galerkin weighted residual method of finite element. The authors claim that any obstacle makes some significant influences on the MHD mixed convection flow. Pirmohammadi and Ghassemi (2009) study the effect of magnetic field on convection heat transfer inside a tilted square enclosure. The authors investigate the laminar natural convection flows in the presence of a longitudinal magnetic field in a tilted enclosure that is heated from below and cooled from the top while other walls were adiabatic. Saha (2013) investigates the effect of MHD and heat generation on natural convection flow in an open square cavity under microgravity condition ( $g \approx 0$ ) and under a uniform vertical gradient magnetic field in an open square cavity with three cold sidewalls. The author concludes that the heat transfer rate is suppressed with the increase of the magnetic Rayleigh number and the paramagnetic fluid parameter for the present investigation. Park *et al.* (2018) observes the effect of the variation in the bottom wall temperature on fluid flow and heat transfer in the enclosure with a circular cylinder for different Rayleigh numbers in the range of  $10^3 \leq Ra \leq 10^6$ . The authors view that



for  $Ra = 10^3$ ,  $10^4$  and  $10^6$ , the value of  $\langle N_{u_t} \rangle$  increased monotonically with increasing  $\theta_b$ , even though variation of  $\langle N_{u_t} \rangle$  according to  $\theta_b$  was very small for  $Ra = 10^3$  and  $10^4$ . Natural convection in a differentially heated square enclosure with a solid polygon is numerically examined by Roslan *et al.* (2014) with the finding that the strength of the flow and inner heat circulations is much higher for greater  $N$ . Hosseini and Roohi (2021) investigate into the MHD unsteady natural convection around a hot elliptical cylinder in a cold rhombus enclosure filled with a nanofluid by immersed boundary method. The results of this investigation illustrate that the whole area is affected by the magnetic field.

The literature reviewed above reveals that there is no significant information on MHD natural convection flow when three half-circular heated blocks exist along the bottom wall of the rectangular enclosure. The present study deals with the effects of magnetic field which may decrease or increase the heat transfer on natural convection in the enclosure. Numerical clarifications are demonstrated over a wide range of Rayleigh, Hartmann, and Prandtl number. The simulated results are exhibited graphically in terms of streamlines and isothermal lines. Finally, the average Nusselt number ( $Nu_{av}$ ), the average velocity magnitude ( $V_{av}$ ) and the average fluid temperature ( $\theta_{av}$ ) of the rectangular enclosure are calculated.

## 2. Experiment

### 2.1 Physical Configuration

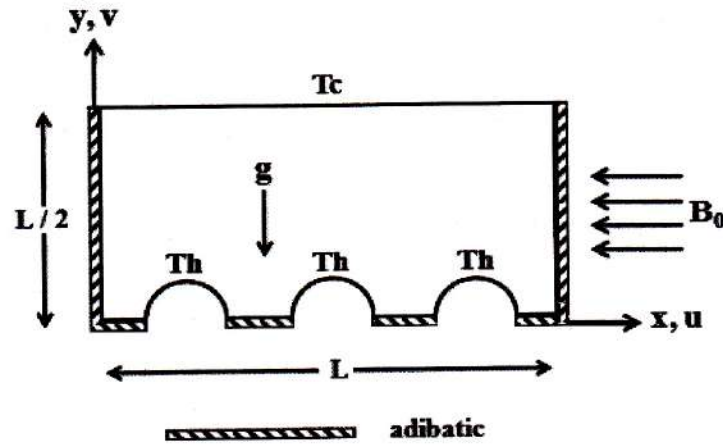


Fig. 1: Schematic diagram of the physical problem

A schematic diagram of the physical system measured in the present research is shown in Fig. 1. The system consists of a rectangular enclosure with horizontal side of length  $L$ , vertical side of length  $L/2$  and three upper half cylindrical bodies located at three different places of the lower side of the rectangular enclosure. A Cartesian co-ordinate system is used with origin at the lower left corner of the computational area. The top wall of the enclosure is considered at a cold temperature  $T_c$ , three upper half cylindrical bodies are considered at a heated temperature  $T_h$ , while the rest of the sides are kept adiabatic. Here  $T_c$  is much less than  $T_h$ . A magnetic field of strength  $B_0$  is affected horizontally normal to the adiabatic side walls.

### 2.2 Mathematical Formulation

In magneto-hydrodynamics (MHD), fluid motion is ruled by the laws of conservation of mass, momentum and energy. In the present research, it has been considered that the flow is steady, two-dimensional, laminar, and incompressible and there is no viscous dissipation. The gravitational force performs in the vertically downward direction and the radiation

effect is neglected. The non-dimensional governing equations under Boussinesq approximation are as follows:

$$\frac{\partial U}{\partial X} + \frac{\partial V}{\partial Y} = 0 \quad (1)$$

$$U \frac{\partial U}{\partial X} + V \frac{\partial U}{\partial Y} = -\frac{\partial P}{\partial X} + \text{Pr} \left( \frac{\partial^2 U}{\partial X^2} + \frac{\partial^2 U}{\partial Y^2} \right) \quad (2)$$

$$U \frac{\partial V}{\partial X} + V \frac{\partial V}{\partial Y} = -\frac{\partial P}{\partial Y} + \text{Pr} \left( \frac{\partial^2 V}{\partial X^2} + \frac{\partial^2 V}{\partial Y^2} \right) + Ra \text{Pr} \theta - Ha^2 \text{Pr} V \quad (3)$$

$$U \frac{\partial \theta}{\partial X} + V \frac{\partial \theta}{\partial Y} = \frac{\partial^2 \theta}{\partial X^2} + \frac{\partial^2 \theta}{\partial Y^2} \quad (4)$$

For the above equations (1) – (4), the following definitions and dimensionless parameters are used

$$X = \frac{x}{H}, Y = \frac{y}{H}, A = \frac{a}{L^2}, U = \frac{uL}{\alpha}, V = \frac{vL}{\alpha}, P = \frac{pL^2}{\rho\alpha^2}, \theta = \frac{T - T_c}{T_h - T_c}$$

where  $\text{Pr} = \frac{\nu}{\alpha}$  is Prandtl number,  $Ra = \frac{g\beta(T_h - T_c)L^3}{\nu\alpha}$  is Rayleigh

number and  $Ha$  is Hartmann number which is defined as  $Ha^2 = \frac{\sigma B_0 L^2}{\mu}$

The non-dimensional boundary conditions under consideration can be written as

$$\begin{aligned} P &= 0 \text{ at all boundaries,} \\ U(X,0) &= U(X,0.5) = U(0,Y) = U(1,Y) = 0, \\ V(X,0) &= V(X,0.5) = V(0,Y) = V(1,Y) = 0, \end{aligned}$$

$$\theta(X,0.5) = 0, \frac{\partial \theta}{\partial X}(0,Y) = \frac{\partial \theta}{\partial X}(1,Y) = 0$$

$$\frac{\partial \theta}{\partial Y}(X,0) = 0, \forall 0 \leq X \leq 0.067, 0.267 \leq X \leq 0.4, 0.6 \leq X \leq 0.733$$

and  $0.933 \leq X \leq 1$

At the circular body surfaces  $U(X,Y) = V(X,Y) = 0, \theta(X,Y) = 1$

The average Nusselt number at the upper half-circular heated blocks of the rectangular enclosure may be expressed as

$$Nu_{av} = -\frac{1}{L_s} \int_0^{L_s/L} \frac{\partial \theta}{\partial n} dS$$

where,  $\frac{\partial \theta}{\partial n} = \sqrt{\left(\frac{\partial \theta}{\partial X}\right)^2 + \left(\frac{\partial \theta}{\partial Y}\right)^2}$  and  $S$  is the non-dimensional coordinate along the rectangular surface.

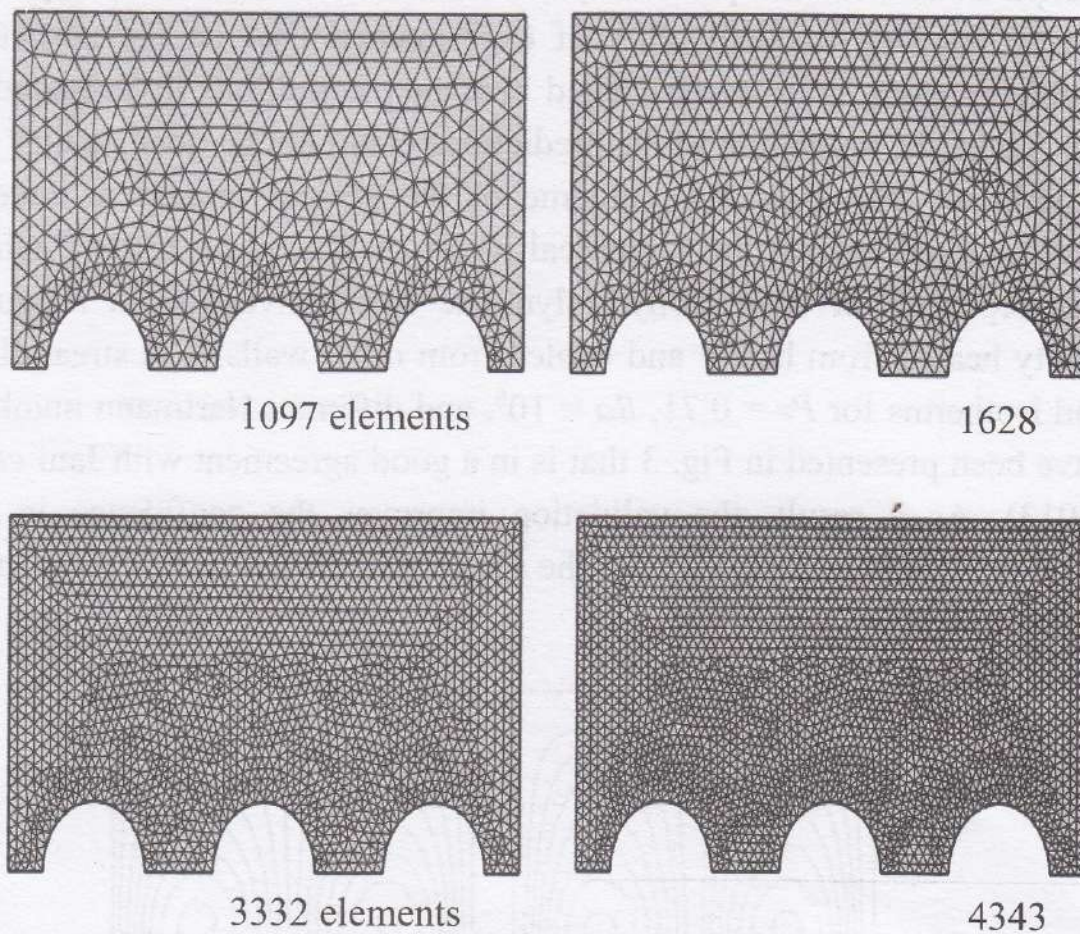
### 2.3 Numerical Technique

The governing equations along with the boundary conditions have been solved numerically, using Galerkin weighted residual finite element techniques (Zienkiewicz and Taylor, 1991). The solution domain is discretized into finite element grids, which are self-assured of non-uniform triangular elements. Then the nonlinear governing partial differential equations (i.e., mass, momentum and energy equations) are shifted into a system of integral equations by applying Galerkin weighted residual method. The nonlinear algebraic equations are modified by the imposition of boundary conditions and transferred into linear algebraic equations by using Newton's method. Moreover, the application of this method is well described by Taylor & Hood (1973) and Dechaumphai (1999).

### 2.4 Grid Sensitivity

To determine the appropriate grids for the numerical investigation, a grid independence study is assumed for MHD natural convection analysis in a rectangular enclosure with half-circular heated blocks considered in

Fig. 2 at  $Ra = 10^5$ ,  $Pr = 0.7$  and  $Ha = 20$ . Four different uniform grids, namely, 1097, 1628, 3332 and 4343 elements are used and for each grid size, the average Nusselt number ( $Nu_{av}$ ) of the heated circular walls is obtained.



**Fig. 2: Different mesh structure of elements for the Schematic diagram**

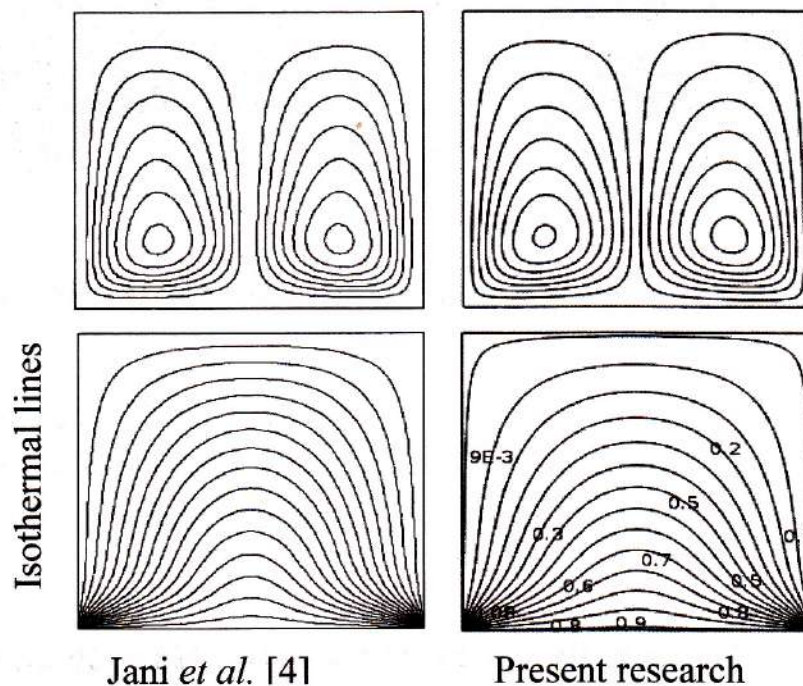
Table I exhibits the average Nusselt number ( $Nu_{av}$ ) of the heated half-circular walls for different grids. As it can be found from Table I, 3332 uniform grids are sufficiently okay to make sure a grid-independent solution.

**Table I: Grid Sensitivity Check at  $Ra = 10^5$ ,  $Ha = 20$  and  $Pr = 0.7$ .**

Elements	1097	1628	3332	4343
$Nu_{av}$	2.19467	2.2013	2.21419	2.22766

## 2.5 Code Validation

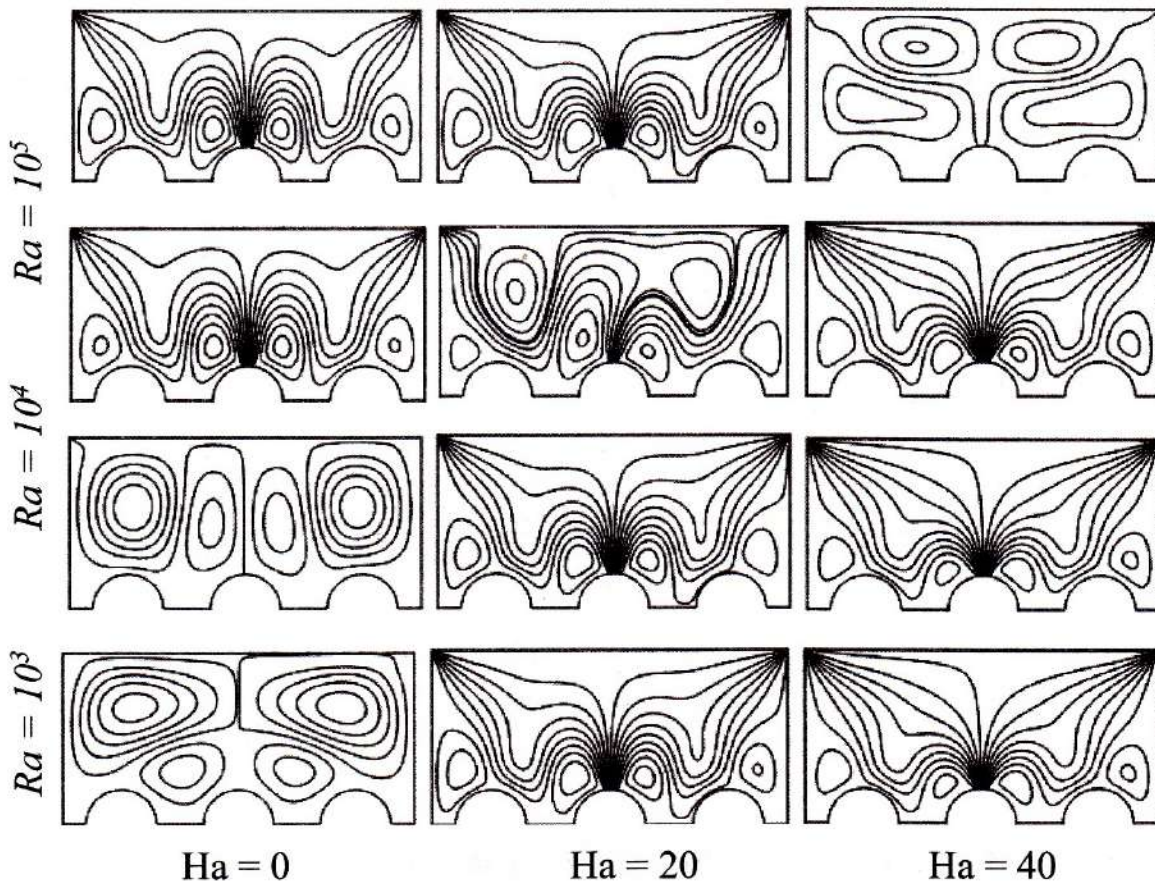
To confirm the correctness of the numerical results and the validity of the mathematical model obtained throughout the present study, comparisons with the previously published results are necessary. But due to the lack of availability of experimental data on the particular problems along with its associated boundary conditions investigated in this study, the validation of the predictions could not be done against the experiment. However, the outcome of the present numerical code is benchmarked against the numerical result of Jani *et al.* (2013), which was reported for Magnetohydrodynamic free convection in a square cavity heated from below and cooled from other walls. The streamlines and isotherms for  $Pr = 0.71$ ,  $Ra = 10^6$ , and different Hartmann numbers have been presented in Fig. 3 that is in a good agreement with Jani *et al.* (2013). As a result, the validation improves the confidence in the numerical code to carry on with the above stated objective of the current investigation.



**Fig. 3: Comparison of streamlines and isothermal lines between present research and Jani *et al.* (2013), where  $Ra = 10^5$ ,  $Ha = 50$  and  $Pr = 0.71$ .**

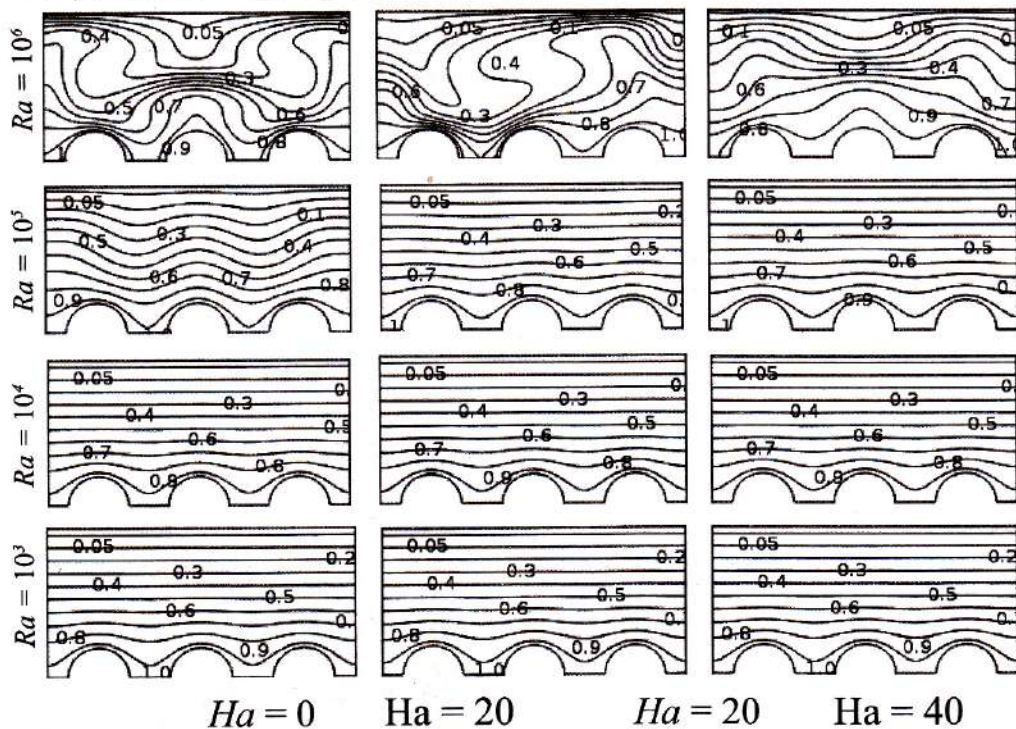
### 3. Results and Discussion

Weighted residual finite element simulation is applied to execute the analysis of laminar natural convection heat transfer and fluid flow in the rectangular enclosure with three heated half-circular blocks along the bottom wall. Effects of the parameters such as Rayleigh number ( $Ra$ ), Hartmann number ( $Ha$ ) and Prandtl number ( $Pr$ ) on heat transfer and fluid flow inside the enclosure have been studied. We have exhibited the results in two sections. The first section has focused on flow and temperature fields, which contain streamlines and isothermal lines for the different parameters. Heat transfer including average Nusselt number ( $Nu_{av}$ ) at the heated half-circular blocks, average velocity magnitude ( $V_{av}$ ) and average fluid temperature ( $\theta_{av}$ ) in the enclosure have been discussed in the following section. The ranges of  $Ra$ ,  $Ha$  and  $Pr$  for this investigation vary from  $10^3$  to  $10^6$ , 0 to 40 and 0.10 to 0.98 respectively.



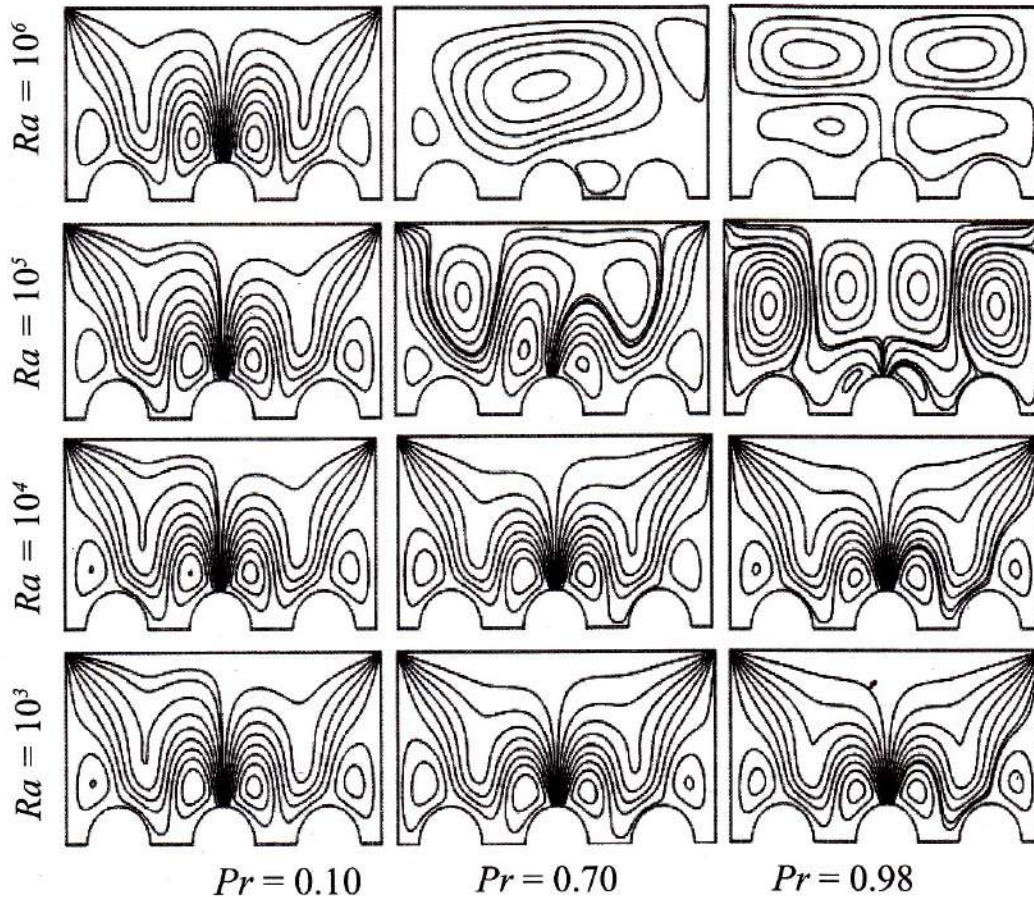
**Fig. 4: Streamlines for different Rayleigh number ( $Ra$ ) and Hartmann number ( $Ha$ ), where Prandtl number  $Pr = 0.70$ .**

The effect of Rayleigh number  $Ra$  (from  $10^3$  to  $10^6$ ) on streamlines for the present configuration at different Hartmann numbers ( $Ha = 0, 20, 40$ ) and  $Pr = 0.70$  have been exhibited in Fig. 4. The fluid flow is affected by the buoyancy force and creating one pair of symmetric vortex near the heated blocks and another pair of symmetric vortex have been observed near the top wall of the enclosure, when  $Ra = 10^3$  and  $Ha = 0$ . For different  $Ha$ , the strength of the velocity magnitude increases with the increase of  $Ra$  from  $10^3$  to  $10^6$ . The maximum velocity magnitude (200.67 m/s) for this model has been seen at the point (0.50, 0.16), when  $Ra = 10^6$ ,  $Ha = 20$  and  $Pr = .70$ . Six different contours have been found, when  $Ra = 10^5$  and  $Ha = 20$ . Fig. 5 demonstrates the temperature field in the flow region. The high-temperature region remains near the heated half-circular blocks and the isothermal lines are approximately linear and parallel to the top wall for  $Ra = 10^3$  to  $10^5$ . On the other side, the isothermal lines alter their directions irregularly for  $Ra = 10^6$ , and  $Ha = 0, 20, 40$ .



**Fig. 5: Isothermal lines for different Rayleigh number ( $Ra$ ) and Hartmann number ( $Ha$ ), where Prandtl number  $Pr = 0.70$ .**



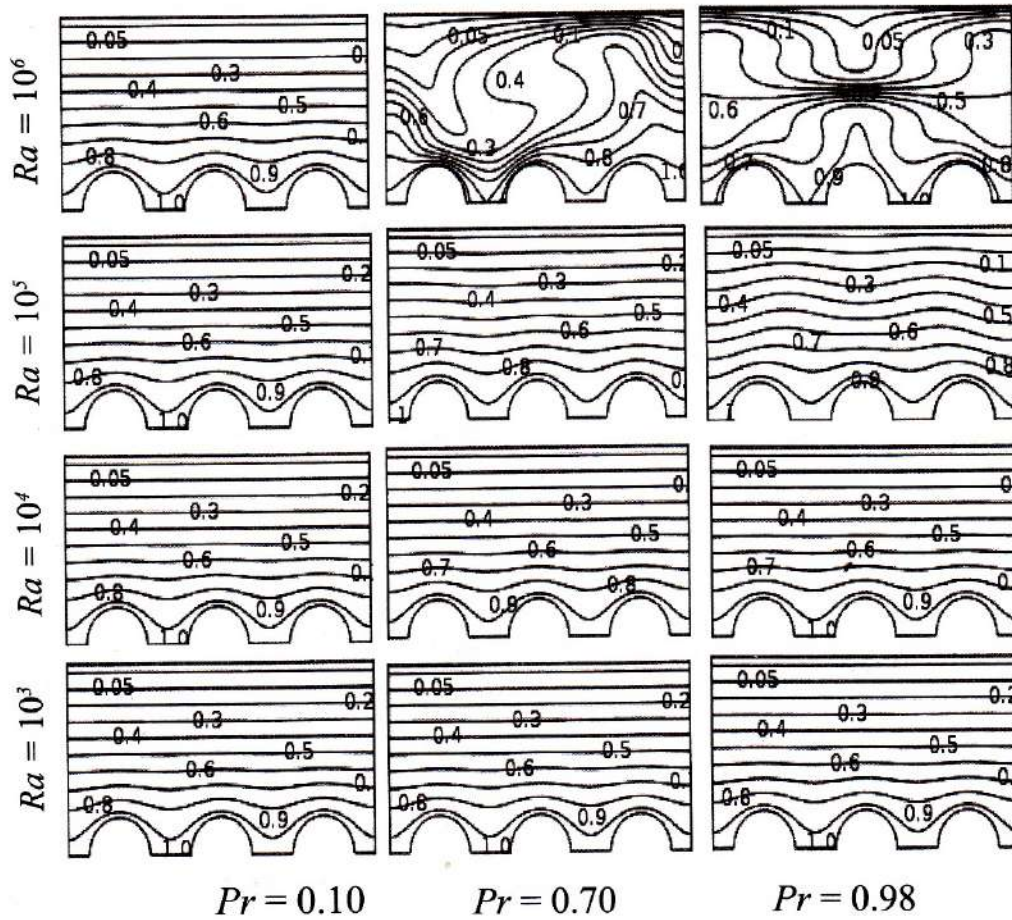


**Fig. 6: Streamlines for different Rayleigh number ( $Ra$ ) and Prandtl number ( $Pr$ ), where Hartmann number  $Ha = 20$ .**

Fig. 6 reveals the effect of Prandtl number  $Pr$  (from 0.10 to 0.98) via Rayleigh numbers  $Ra$  (from  $10^3$  to  $10^6$ ) on flow and thermal field, when  $Ha = 20$ . Most of the streamlines exhibit the same pattern for low Prandtl numbers  $Pr = 0.10$ ), where  $Ra = 10^3$  to  $10^6$  and  $Ha = 20$ . The vorticity increases very quickly for  $Pr = 0.70$  and  $Ra = 10^3$  to  $10^6$ -A large size of the vortex has been viewed near the center of the enclosure for  $Ra = 10^6$ ,  $Pr = 0.70$  and  $Ha = 20$ .

The effect of Prandtl number  $Pr$  ( $Pr = 0.10, 0.70, 0.98$ ) on the isothermal lines for the present figure at  $Ha = 20$  has been overlooked in Fig. 7, where  $Ra$  varies  $10^3$  to  $10^6$ . Utmost heated isothermal lines have shown near the half-circular blocks and the shapes of lines seemed

sinusoidal. Some isothermal lines have been concentrated horizontally at the center of the enclosure for  $Ra = 10^6$ ,  $Pr = 0.98$  and  $Ha = 20$ .

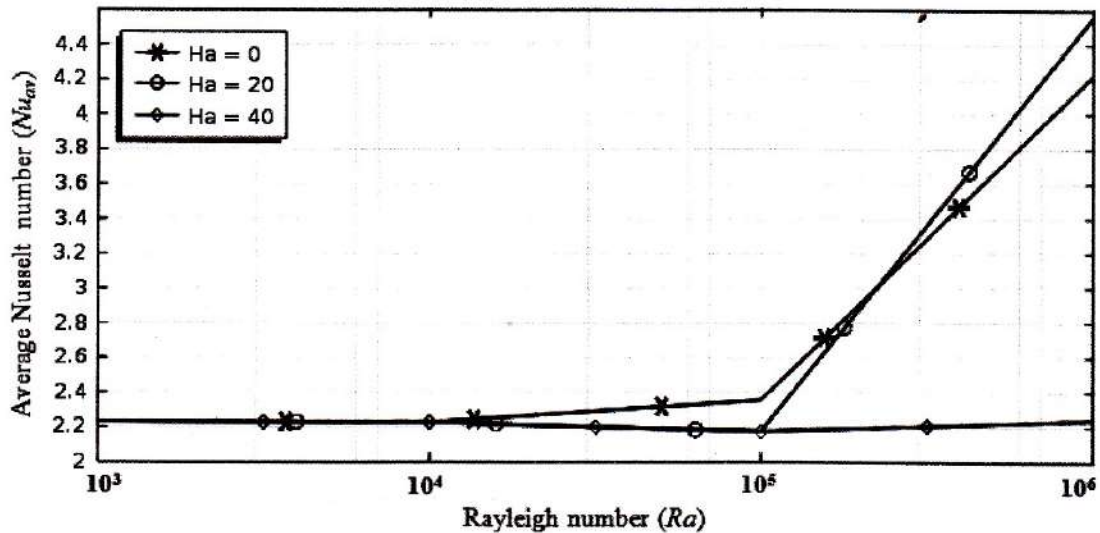


**Fig. 7: Isothermal lines for different Rayleigh number ( $Ra$ ) and Prandtl number ( $Pr$ ), where Hartmann number  $Ha = 20$ .**

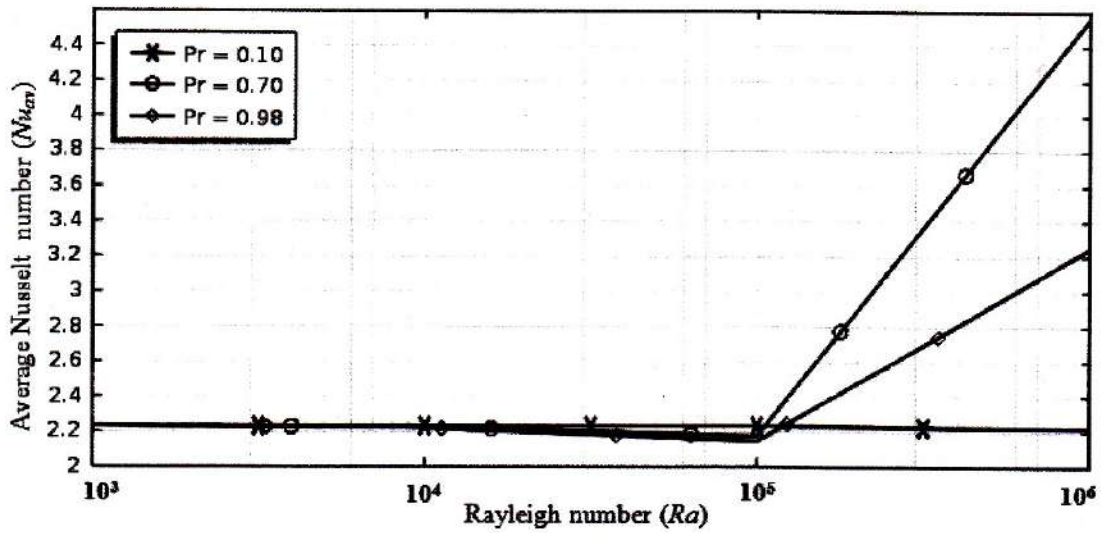
In order to evaluate how the presence of magnetic field parameter Hartmann number ( $Ha$ ) affects the heat transfer rate along the heated half-circular blocks, the average Nusselt number ( $Nu_{av}$ ) is plotted as a function of Rayleigh number ( $Ra$ ) as shown in Fig. 8 for three different Hartmann numbers ( $Ha = 0, 20$  and  $40$ ), while  $Pr = 0.70$ . It is observed that the convection and conduction are approximately the same for  $10^3 < Ra < 10^5$  but the convection flow is dominated for  $Ra > 10^5$ . On the other hand, no effect of  $Nu_{av}$  is found in the absence of MHD ( $Ha = 0$ ) effect. Fig. 9 shows the effect of Rayleigh number ( $Ra$ ) on  $Nu_{av}$  for several Prandtl numbers ( $Pr = 0.10, 0.70$  and  $0.98$ ). All the physical

phenomenon of  $Nu_{av}$  regarding the variation of different Prandtl numbers shows an interesting performance.

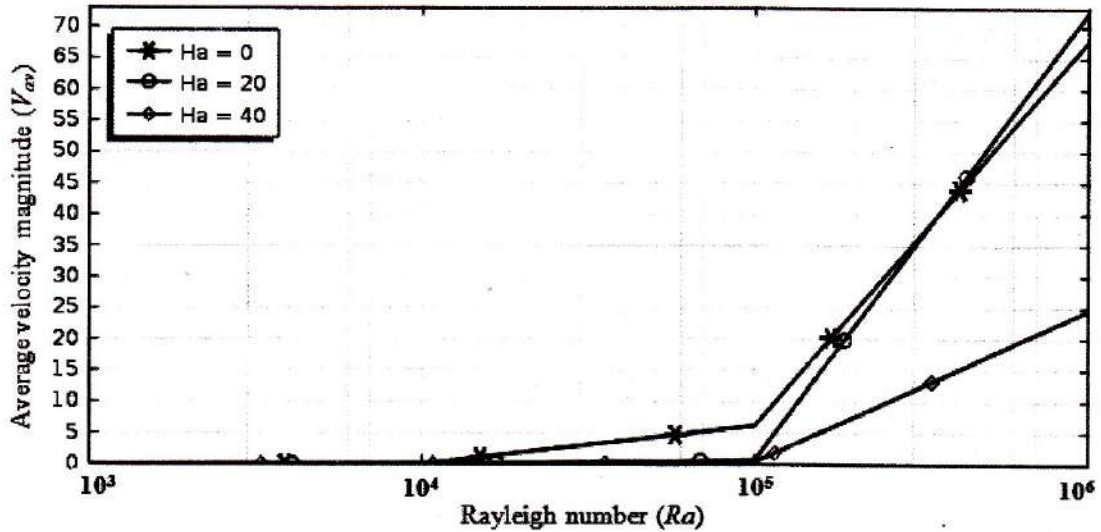
Fig. 10 represents the average velocity magnitude ( $V_{av}$ ) as a function of Rayleigh number ( $Ra$ ) for different  $Ha$ , where  $Pr = 0.70$ . It is clear that the  $V_{av}$  remains nearly zero for low Rayleigh number ( $Ra = 10^3-10^4$ ) and then rises up. Average fluid temperature ( $\theta_{av}$ ) in the rectangular enclosure has been investigated in Fig. 11 as a function of Rayleigh number ( $Ra$ ) for different  $Ha$ . The  $\theta_{av}$  varies from 0.519 to 0.575 for various  $Ha$  and  $Ra$ , where  $Pr = 0.70$ . Besides, in the absence of MHD ( $Ha = 0$ ), the  $\theta_{av}$  falls slightly, when  $Ra$  varies from  $10^5$  to  $10^6$  and the rest of the  $\theta_{av}$  (for  $Ha = 20$  and  $40$ ) increase with the increase of  $Ra$  from  $10^5$  to  $10^6$ .



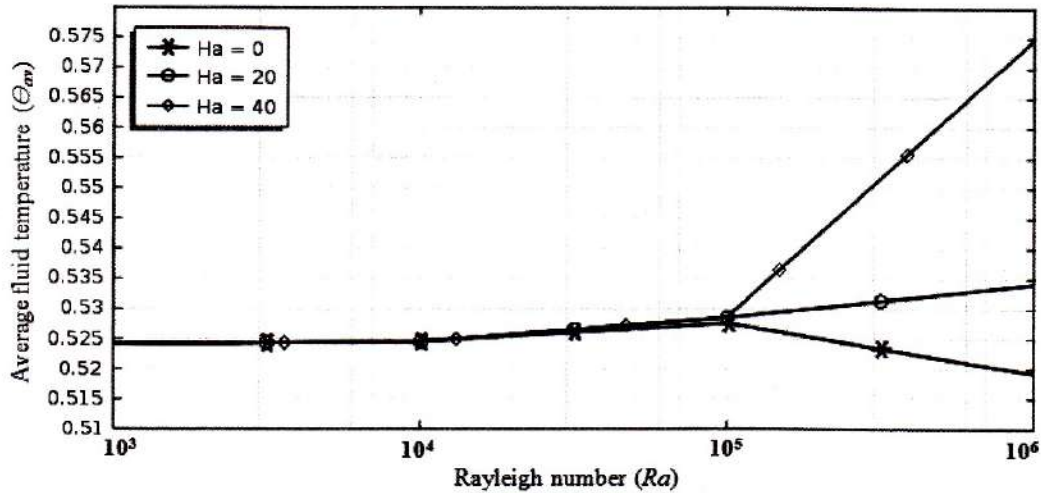
**Fig. 8: Effect of Rayleigh number ( $Ra$ ) on average Nusselt number ( $Nu_{av}$ ) for different Hartmann number ( $Ha$ ), where  $Pr = 0.70$ .**



**Fig. 9: Effect of Rayleigh number ( $Ra$ ) on average Nusselt number ( $Nu_{av}$ ) for different Prandtl number ( $Pr$ ), where  $Ha = 20$ .**



**Fig. 10: Effect of Rayleigh number ( $Ra$ ) on average velocity magnitude ( $V_{av}$ ) for different Hartmann number ( $Ha$ ), where  $Pr = 0.70$ .**



**Fig. 11: Effect of Rayleigh number ( $Ra$ ) on average fluid temperature ( $\Theta_{av}$ ) for different Hartmann number ( $Ha$ ), where  $Pr = 0.70$ .**

#### 4. Conclusion

A finite element method is used to make the present research for steady-state, incompressible, laminar and MHD natural convection flow in a rectangular enclosure with three half-circular heated blocks. The leading conclusions have been drawn as follows:

- The natural convection parameter  $Ra$  has a considerable effect on the flow and temperature fields. For a certain condition  $Ra = 10^6$ ,  $Ha = 20$  and  $Pr = 0.70$  the strength of the velocity magnitude is maximum (200.67 m/s).
- The influence of magnetic parameter  $Ha$  on streamlines and isothermal lines is remarkable. The isothermal lines alter their directions frequently for large  $Ra = 10^6$ , where  $Ha$  varies from 0 to 40.
- The range of the average Nusselt number ( $Nu_{av}$ ) lies between 2.18 to 4.55 and  $Nu_{av}$  increases quickly for  $Ra = 10^5$  to  $10^6$ .
- Mentionable variation of  $\Theta_{av}$  is seen for  $Ra = 10^5$  to  $10^6$  and different Hartmann number ( $Ha = 0, 20$  and  $40$ ).

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# **A Study on Solar Potential on the Roof Surface Area of Launch in Dhaka Sadarghat Region in Bangladesh**

**Md. Maidul Islam<sup>1</sup> Sujal Kumar Sarker<sup>2</sup> Morshadur Rahman<sup>3</sup> and Md. Arman Hossain<sup>4</sup>**

## **Abstract**

*This article focuses on the use of solar power in a particular and effective way. Nowadays, many people use solar power. It is proved now that the necessity and the acceptability of the solar panel devices for using solar power are on increase rapidly in Bangladesh. We can use solar power in different convenient fields depending on sun and heat. Launches are one of the best ways to use solar power on the rooftop. Because there is available space on the rooftop of the two and three-decked launches. So we can easily set up solar panels here because it has become essential for us to use solar power instead of fuel power to save our environment from being polluted.*

**Keywords:** Renewable Energy, Solar Potential, Passenger Launch, Roof Surface, Solar Tilt Radiation.

## **1. Introduction**

In Bangladesh, about 700 rivers and tributaries capture a total of 24,140 kilometers (km) of land in length. According to Bangladesh Inland Water Transport Authority (BIWTA), the navigable river routes in Bangladesh

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during the monsoon reach about 6,000 km (Fig.1 shows the river network navigable). The length is about 3,900km in the dry season (<http://www.biwta.gov.bd>). About 90 million passengers travel and 20 million tons of freight are carried by inland waterways every year. Roughly 646 passenger launches operate in 186 routs. BIWTA maintains and supervises 21 river ports and 380 launch terminals.

In Bangladesh, a huge number of people of the rural areas are in an electricity crisis along with increasing energy demand all over the country. As the expansion of the grid is inordinately expensive in the rural areas, already initiatives have been taken to popularize the use of renewable energy sources. The total power generation capacity in Bangladesh is about 25145 MW (Including Off-Grid RE, as updated on 19<sup>th</sup> June 2021) (<http://www.sreda.gov.bd>). The renewable energy shares about 2.91% of total generation (Renewable Energy Master Database 2021). At present Solar PV contributes 68% of total renewable energy in Bangladesh (<http://www.sreda.gov.bd>). By 2030, the total electricity generation capacity will increase to 39000 MW. As a future plan, Bangladesh aims at 10% of renewables share in the total energy generation by 2021 (Renewable Energy Master Database 2021). The greatest amount of solar energy is available between two broadband encircling the earth between 15° and 35° latitude north and south. Graphically, Bangladesh is situated in the north-eastern part of South Asia between 20<sup>o</sup>.34' & 26<sup>o</sup>38' north latitude and 88<sup>o</sup>01' & 92<sup>o</sup>41' east longitude. So, as far as fruitful utilization of solar energy is concerned, Bangladesh is situated in a very advantageous location (Bangladesh Bureau of Statistics, March 2017), As such, solar resources can promote 10% of renewable energy share in the total by 2021. But fostering solar resources needs an ample amount of land. Bangladesh being a tiny and populated country may not be able to fulfill this need. As an alternative, rooftops of launches can solve the land crisis and can create floating solar power plants. This paper investigates the solar tilts radiation, available roof surface area of launches in order to

measure the solar photovoltaic potential of launches in Bangladesh, which will open a new area of power generation through PV application.

## **2. Literature Review**

Fossil fuel energy resources are being diminished. Negative environmental impacts (e.g. greenhouse gas) of fossil fuel are one of the barriers to use it. The solution to this new environmental problem is to find alternative power generation sources to meet future demand. This will doubtlessly signify a decrease in fossil fuel energy consumption and, at the same time, an increase in the production of renewable energies or energies generated from natural resources. With the invention of advanced renewable energies, technologies offer alternative solution to negative environmental impacts (Jefferson, 2006). Solar energy is one the resources of the natural energy sources. Solar Energy is boundless and pollution-free. It is now being widely used for electrical power generation. A rigorous study is continuing to search for the solution for fruitful utilization of solar energy. Now, many developed countries are generating power from solar energy sources. But per unit power generation from solar energy cost is high for large land area use. Researches find that residential roof-top area has been used to reduce land area cost for solar energy generation. According to Ordóñez *et al* (2010), the photovoltaic solar energy capacity for residential building rooftops in Andalusia (Spain) city, if photovoltaic arrays were installed on all of them, is calculated at 9.73 GW/year for a total roof surface of 265.52 km. Some researchers undertake studies to estimate the accurate roof surface area because more estimated roof surface area will give more solar energy capacity. Hongand others (2017) develop a method for estimating the rooftop solar PV potential based on available rooftop area using Hillshade analysis. Toward this end, the rooftop solar PV potential was estimated in the following procedures: (i) calculation of the physical potential; (ii) calculation of the geographic potential; and (iii)

calculation of the technical potential. Among these three rooftop solar PV potentials, the geographic potential was mostly taken into account to acquire an accurate and reliable estimation result (Hong *et al.* 2017). A number of scholars, e.g, Wiginton *et al.* (2010), Byrne *et al.* (2015), Singh and Banerjee (2015), Arnette (2013), Ko *et al.* (2015), Kodysh *et al.* (2013), Lukač *et al.* (2013), Levinson *et al.* (2009), have quantified rooftop solar photovoltaic potential for regional renewable energy policy for various cities (e.g. Taiwan, Seoul, California). In 2000, Chakraborty and others (2016) investigated the PV potential output on the roof-top surface of registered trawlers in Chittagong region in Bangladesh. The total PV panel output for every year for 2000 trawlers will be changed to 518.86 MW and 258.08 MW if solar polycrystalline and solar thin-film technologies are used, respectively (Chakraborty *et al.*, 2016).

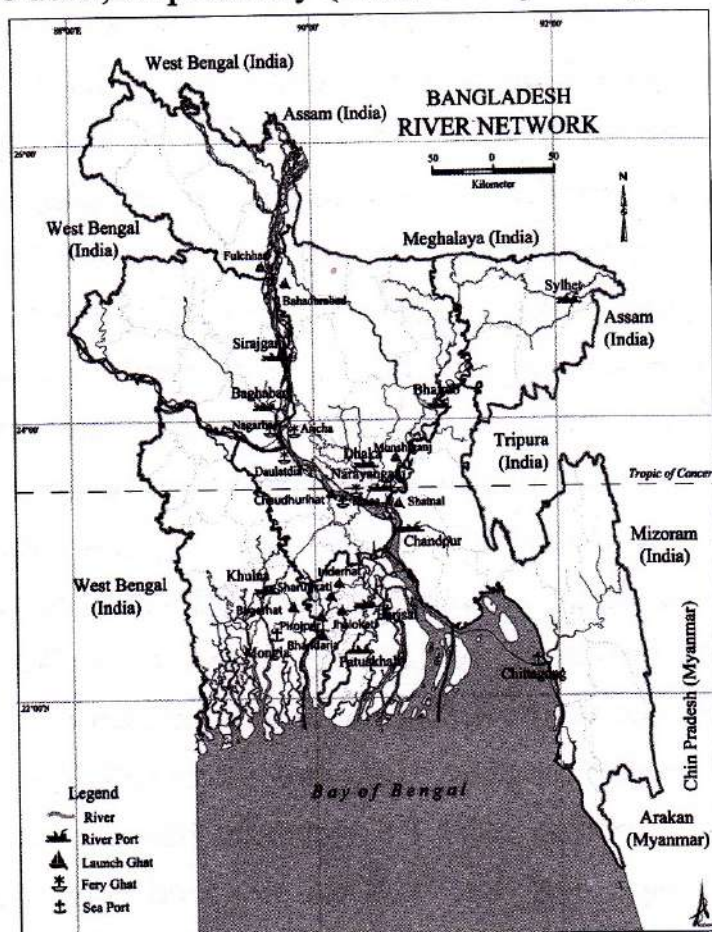


Fig. 1. Map of Bangladesh river network navigable (inset).

### **3. Justification of the Research**

Generally, launch is driven by an engine that uses oil as fuel. A propeller (a fan-like structure) is used to propel the launch by using the power generated and transmitted by the main engine. The transmitted power is converted from rotational motion to generate a thrust which imparts momentum to the water, resulting in a force that acts on the launch and pushes it forward. A marine generator working is based on the principle of electromagnetic induction. On a launch, the electricity can be produced by using the ship's auxiliary engine which consists of a marine prime mover and alternator. There is an electricity demand for electric bulbs, fans, air conditioners in the launch. The top floor area of the launch is unutilized or empty. Available roof surface area of the launch can be used to generate solar power that will meet the electricity demand of the launch. The surplus solar power can be transmitted into the grid when the launch waits at the station. This paper investigates into the solar tilts radiation from the available roof surface area of launches in order to measure their solar photovoltaic potential in Dhaka Shadarghat, Bangladesh, which will open a new area of power generation through PV application.

### **4. Methodology**

To find solar potential on the rooftop of launch, the data availability is a major issue. So, a four-step methodology is used in this paper to investigate the launch rooftop solar potential utilizing available data and resources. Fig. 2 shows the block diagram of the proposed methodology. At first, launches were surveyed to get the length and width of the launch. Average solar radiation on the horizontal surface in Dhaka is also collected. In the second step, solar tilt radiation is calculated from the available solar horizontal radiation data using several formulas. In the third step, the available roof surface area is calculated considering different parameters. In the final step, the solar potential of a passenger launch is calculated using mono-crystalline and polycrystalline PV technologies.

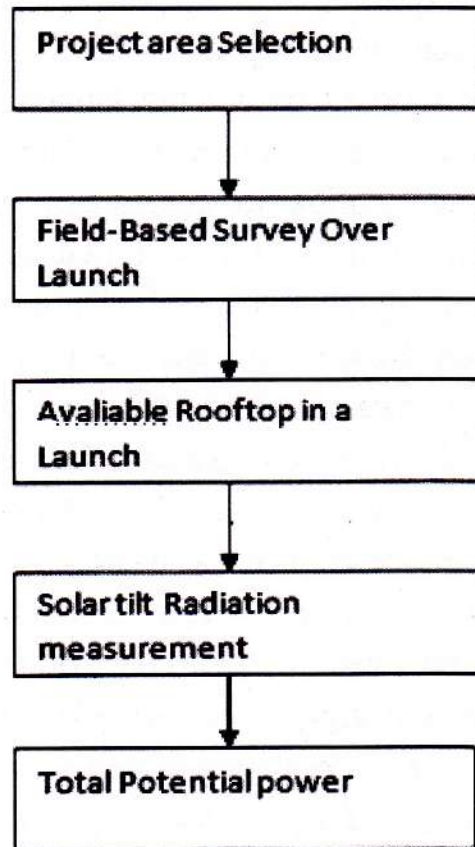


Fig. 2. Steps to find solar potential in rooftop of passenger launches

#### 4.1 Method of Data Collection

The measurement of the rooftop area of a passenger launch is taken from the field-based survey. Around 646 passenger launches are running in 186 routes. Actually, in Bangladeshi passenger launches, vacant roof surface areas are available. The vacant roof space of two-deck and three-deck passenger launches shown in Fig. 3 is estimated. Schematically, the top area of the passenger launches is drawn in fig. 4. The length of a two-deck launch is 178.5ft and the width is 30ft. The radius of the semicircular surface of two-deck launch is found 25ft. the total area of a two-deck launch is estimated 6425.5 sq. ft. Actually, the top surface area is divided into two sections: one of them is semicircular surface and the other rectangular surface. There are some necessary objects situated on rectangular surface sections. Wide and length of the semicircular surface, rectangular surface and necessary objects are surveyed by visiting at on-site Sadarghat Launch Terminal.



Fig. 3. Roof surface of a passenger launch

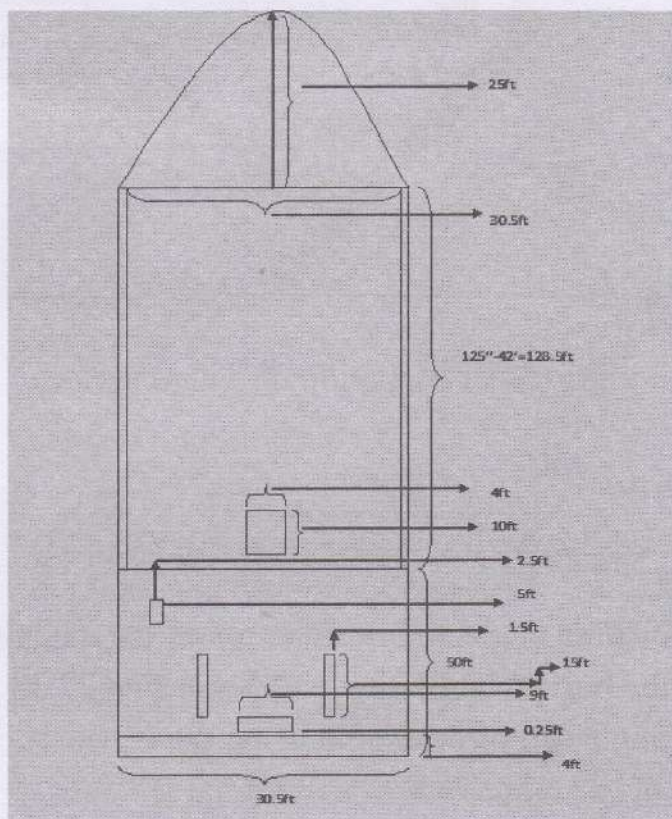


Fig. 4. Top view of a passenger launch

## 4.2 Solar Tilt Radiation Measurement

To find out solar radiation on the rooftop area of passenger launches, one important issue needs to be considered. As the solar panel will be having a fixed tilt angle with the horizontal surface, solar tilt radiation needs to be measured at first. To extract maximum power throughout a year at a fixed tilt angle, the tilt angle needs to be exactly equal to the latitude of the place (<http://pveducation.org/pvcdrom/properties-of-sunlight/solar-radiation-on-tilted-surface>). The latitude of Dhaka 22.78 is used as the tilt angle of the solar PV system on the rooftop of launches. Solar radiation on the tilted surface  $S_{module}$  can be calculated using either solar radiation calculated on a horizontal surface  $S_{horiz}$  or solar radiation calculated perpendicular to the sun  $S_{incident}$ .

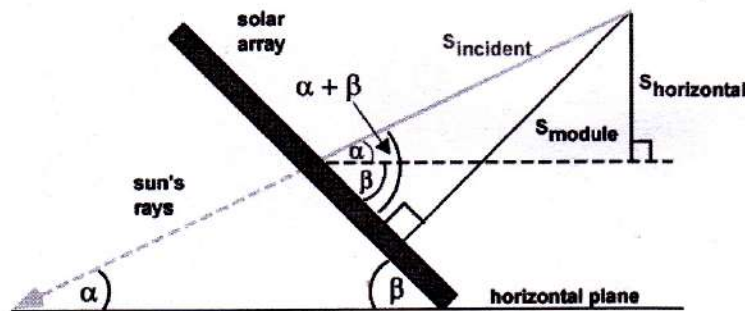


Fig.5. Solar Radiation on Tilted surface

$$S_{horiz} = S_{incident} \sin \alpha \dots\dots\dots(1)$$

$$S_{module} = S_{incident} \sin(\alpha + \beta) \dots\dots\dots(2)$$

Where  $\alpha$ =the elevation angle and  $\beta$ =tilt angle of the module measured from the horizontal= latitude of Sadarghat 22.78

Now, elevation angle can be measured using the equation:

$$\alpha = 90 - \phi + \delta \dots\dots\dots(3)$$

Where,  $\phi$ = latitude=22.78,  $\delta$ =declination angle.  
Declination angle can be found using the equation



$$\delta = 23.45 \sin\left[\frac{360}{365}(284+d)\right] \dots\dots\dots(4)$$

Where d is denoted as the number of the day of a year, Combining these equations, the tilt radiation,  $S_{module}$  can be found using the equation:

$$S_{module} = S_{horiz} \frac{\sin(\alpha + \beta)}{\sin \alpha} \dots\dots\dots(5)$$

Using this equation  $S_{module}$  is calculated. For the realistic calculation, Using this equation  $S_{module}$  is calculated. For the realistic calculation, So,  $S_{module}$  data was calculated differently for south-facing  $S_{horiz}$  data for south-facing, taken from the website (<http://www.efficientenergysaving.co.uk/solar-irradiance-calculator.html>).

### 4.3 Estimation of Available Roof Surface Area of Launches

In this research, two types of launch-two-deck and three-deck-areconsidered. The length of a two-deck is 178.5ft and the width is 30ft. The dimension and measuredvalue indicating the area is almost the same as a half-circular area. The radius of the semicircular surface of two-deck launch is found=25ft. The available roof surface area is measured using the following equation (Bergamasco and Asinari, 2011):

$$S_{Roof} = C_{RT} \cdot C_F \cdot C_{ST} \cdot C_{cov} \cdot C_{SH} \cdot \frac{S_{roof}}{\cos \theta} \dots\dots\dots(6)$$

For a fixed tilt angle, the maximum amount of power per annum is attained when the tilt angle is equal to the latitude of the location. So the solar panel will be installed having a tilt angle of 22.78 with the horizontal to match with the latitude of Dhaka Sadorghat to Barishal. The roof-type coefficient  $C_{RT}$  in this paper is assumed to be 1, the feature coefficient  $C_F$  is equal to 0.9 considering that 10% of space is occupied by chimney and railing. In Bangladeshi launches, solar thermal system is not installed generally, so solar thermal coefficient  $C_{ST}$  is considered 1. The covering index coefficient  $C_{cov}$  is 0.45 (Bergamasco and Asinari, 2011), which

ensures that there are enough gaps between the solar panels. The shadowing coefficient  $C_{SH}$  is considered as 1 as launches are being driven in the river are observed at no shadows. The total area of a two-deck launch is estimated at 6425.5 sq.ft. Some spaces are occupied by necessary objects such as chimney, railing etc. estimated by 164.65sq.ft

Total vacant area=Total area-Area occupied by objects = 6425.5-164.65=6260.85sq.ft = 581.65 m<sup>2</sup>

According to equation (6), Total available roof space is

$$S_{Roof} = 1*0.9*1*0.45*1*(581.65/0.921) = 255.77 \text{ m}^2$$

#### 4.4 Estimation of Potential Power Output

Nowadays, the most used PV module technologies are monocrystalline, polycrystalline and thin-film. Monocrystalline, polycrystalline technologies are used to analyze potential power. The efficiency  $\eta_{MOD}$  of monocrystalline, poly and thin-film is considered as 20.1%, 16.3% and 8.1% respectively (Bergamasco and Asinari, 2011; Chakraborty *et al.*, 2016). The efficiency decreasing with module lifetime is neglected in this paper. It assumes the losses due to temperature variation and irradiance to be 10% ( $\eta_{TH} = 0.9$ ) (Bergamasco and Asinari, 2011). In order to evaluate the losses due to the incorrect azimuth angle of launch, a corrective coefficient is introduced- azimuthal efficiency  $\eta_{AZ}$ , which is considered as 0.9. Installation losses are considered as 11% ( $\eta_{IN} = 0.89$ ) which includes various losses such as 3% due to the reflection of the sunbeams of the array, 1% due to possible dirt or dust on the PV array, and 2% due to the DC electric panel (Bergamasco and Asinari, 2011). So, considering all above-stated efficiencies  $\eta_{SY}$  can be found by the following formula:

$$\eta_{SY} = \eta_{MOD} \cdot \eta_{TH} \cdot \eta_{AZ} \cdot \eta_{IN} \dots\dots\dots(7)$$

According to equation (7) the system efficiencies for monocrystalline, polycrystalline technologies

$$\eta_{SY} = 0.201 * 0.9 * 0.9 * 0.89 = 0.145 \text{ (Mono Crystal)}$$

$$\eta_{SY} = 0.163 * 0.9 * 0.9 * 0.89 = 0.118 \text{ (Poly Crystal)}$$

The PV potential is calculated using the following equations

$$\text{PV potential} = \text{Solar tilt radiation} \cdot \eta_{\text{SY}} \cdot S_{\text{Roof}}^{\text{Avail}} \dots\dots\dots(8)$$

## 5. Results and Discussion

### 5.1 Solar Tilts Radiation Measurement

Solar tilt radiation module for direct south-facing is collected as shown in Fig. 6.

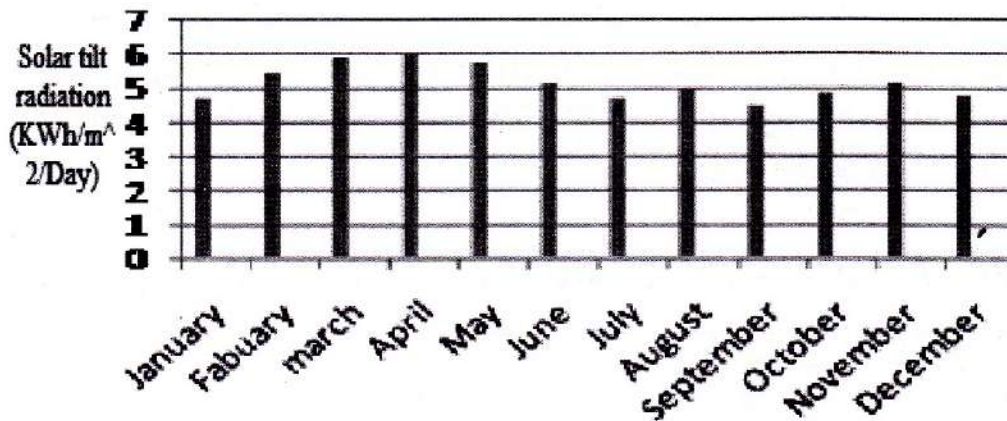


Fig. 6. Solar tilts radiation (south-facing) for different months of a year (<http://nrel.gov/csp>).

From figure 6, it has been observed that monthly solar tilt radiation varies from 6kWh/m<sup>2</sup>/day to 4.5 kWh/m<sup>2</sup>/day. Average solar radiation is a very viable position of solar resources in the world.

### 5.2 Available Roof Surface Area of Launch

Considering all the coefficients and using Equ. 6, the available rooftop area of launch is 255.77m<sup>2</sup>. For the realistic calculation, it is considered that launch is facing directly towards the south.

### 5.3 Potential Power Output

Several steps are followed to find the PV potential. For getting the maximum PV output throughout the year, the panel is considered to have an angle of 22.30 (equal to the latitude of the installed place) with a horizontal surface. So, equation (1)-(5) is used to find the tilt radiation. The area of each passenger launch is 581m<sup>2</sup>. To find out available roof surface area, several parameters including roof-type coefficient, covering index coefficient, shadowing coefficient etc. are considered. The available roof area for solar PV installation of each launch is 255m<sup>2</sup>. Solar radiation, available roof surface area, and system efficiency are used to calculate the PV potential estimated by equation (8). The total monthly PV panel output for each launch is shown in Fig.7

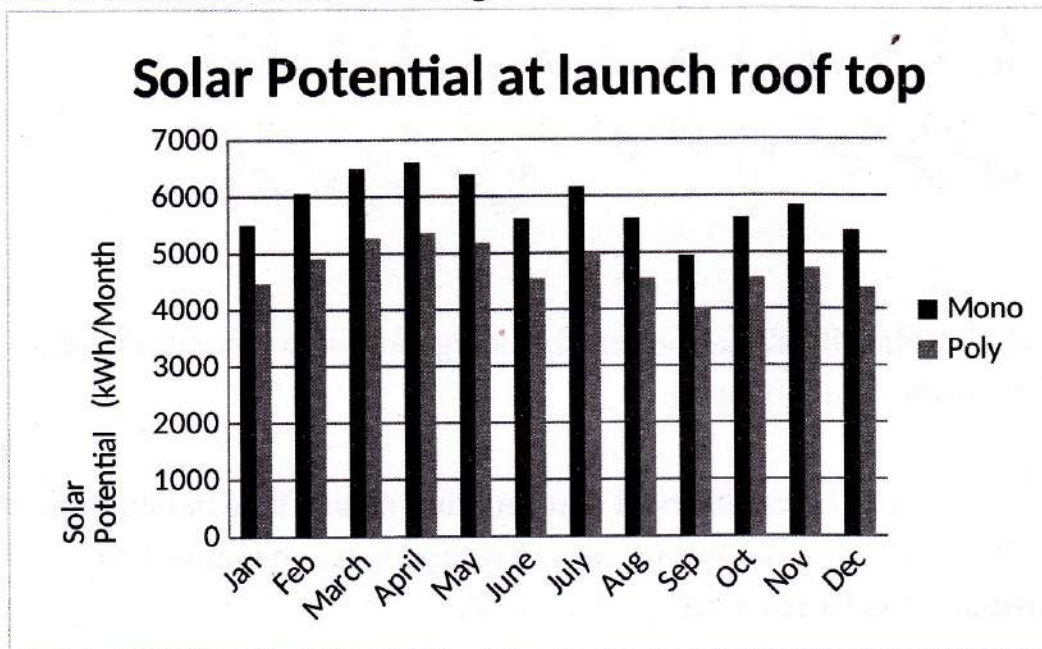


Fig.7. Solar potential for each launches facing direct South.

In Fig.7. Shows monocrystalline solar panel converts solar energy to electrical energy monthly average 6000kWh and 5000kWh for a polycrystalline solar panel at single launch.

Total solar energy 70.225MWh is generated per year utilizing a monocrystalline solar panel and 56.969MWh for polycrystalline from a single passenger launch. Total 24kW solar power will be generated from

one Launch utilizing monocrystalline solar cell and 19.5kW for polycrystalline panel. The total PV panel output for 646 passenger launches (operating in 186 routes in Bangladesh) will be 15.5 MW and 9.6 MW if solar polycrystalline and solar thin-film technologies are used, respectively.

## **6. Conclusion**

In this paper, the PV potential output on the rooftop surface in two-deck launches in Sadarghat region in Bangladesh is investigated. The roof surface of Bangladeshi launches actually has no use. So, the implementation of solar power system in the launch will be a cost effective and efficient system because of avoiding land costs. This paper introduces Bangladesh to a new research field for solar power application, which will mitigate the power crisis of Bangladesh. About 15.5 MW of power will be generated via using rooftop surface areas on 646 passenger launches without any investment in land cost.

## **7. Future Work**

As mentioned above, in this study, the total roof surface area of 646 passenger launches has been investigated, which can be utilized to generate solar power of about 15.5 MW. In the future, an on-grid or off-grid solar PV system for a passenger launch should be designed to evaluate economically viable and low carbon emissions. Solar PV system should be designed in MATLAB environment.

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