THE RISE AND DECLINE OF SCIENTIFIC PRODUCTIVITY IN THE MUSLIM WORLD: A PRELIMINARY ANALYSIS

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Abstract: Scientific productivity has been in decline in the Muslim world since as early as the 15th century and is only now reviving. Many factors have been attributed to the rise and decline, falling under two broad categories: *external* and *internal* influences. The popular understanding of scientific decline in the Muslim world, known as the 'classical narrative' promulgated by orientalists, suggests that only external influences – mainly the synthesis of Persian and Greek elements of civilisation into the Arab imperialist project – were the reasons for the sharp rise of the sciences within Islamic civilisation. Simultaneously, this narrative also suggests that internal influences, exemplified in the impact of Al-Ghazālī's thought towards a more conservative religious approach, as opposed to the more 'rationalist' elements of the Mutazilite School of theology – played the most significant role in decline. This paper shows that the classical narrative is invalid, that there were more legitimate factors at play in both the rise and decline of science in the Muslim world, and that the contemporary stagnation in scientific productivity is a result of this misunderstanding.

Introduction

The Muslim world was once known as a "cradle of civilisation", leading a golden age of scientific discovery and past advancement between the 9th and as far as the 16th century CE, unheard of since the time of the Greeks and their protégés: Plato and Aristotle. New mathematics was constructed, such as Algebra. New medicines, surgical tools and procedures were invented, such as can be evidenced by Ibn Sina's monumental work, *The Canon of Medicine* – used by Muslim and non-Muslim alike as an authoritative source for nearly 700 years. Astronomy was revolutionised to the point where most of the known stars, and the sophisticated astrolabes created to chart them, bear Arabic names – a tribute to their devout observers. Agriculture, architecture, and urban design in the Western part of the Islamic Empire, now modern day Spain, were developed far beyond the limits of any prior civilisation. However, these days are now but a glorified memory in the collective consciousness of the Muslims.

From around the beginning of the 15th century CE, Islamic civilisation took a turn for the worse – a decline which would not rescind till the contemporary era. The current stage of post-regression, what might be called the "Period of Stagnation," has yet to be fully remedied, although many historians and Muslim intellectuals have attempted to diagnose and offer solutions towards curing this ailment.

This paper wishes to assess the popular understanding of the rise, decline, and stagnation of science within the Muslim world, in the hope of discerning whether it represents all three phenomena accurately. What motivates this effort is the hypothesis that the inability to revive scientific productivity – and the misplaced initiatives towards revitalisation among Muslims - is directly linked with this popular conception, and thus it must be challenged so as to pave the way for a newly realised reconstructive initiative for the future.

Constructs of the Discourse

The initial question that should be asked is how the discourse behind rise, decline, and stagnation of scientific productivity in the Muslim word is conducted; meaning, what are the primary terms and concepts incorporated into the research on these phenomena. Understanding these terms and concepts is most important for fully comprehending the subject at hand, which revolves around *scientific* productivity in the Muslim world. It should not be surprising then that the first term that needs to be defined is 'science', especially in the context of the present discussion.

The term 'science' has a long history, for which the scope of this research is not prepared to present an all-encompassing account of in its various usages throughout time. However, comparisons will be made between the traditional understanding of the term based on the perspectives of Islamic scholars, and its Western counterpart; the latter of which is, according to the Oxford Dictionary: "The intellectual and practical activity encompassing the systematic study of the structure and behaviour of the physical and natural world through observation and experiment."[1] In other words, science encompasses the natural study of the physical world through various disciplines such as biology, ecology, medicine, physics, etc. It may also be argued that the common usage of the term includes the aspect of *technology* as well, or the "application of scientific knowledge for practical purposes, especially in industry."[2]

However, according to the traditional Islamic understanding of science, it is a much broader activity that includes other areas of study beyond the scope of the natural world and technology. This broader usage is similarly used in the West in a loose way to define other fields, such as sociology, history, and the like. Osman Bakar, a Muslim scholar who focusses on the philosophy of science from the Islamic perspective, notes the distinction between the formal usages of the term in the West and the Muslim world:

> The different understandings of the term science in the contemporary discourse present another major issue that needs clarification. To begin with, there are disagreements on terminological usage itself, whether

> the domain of knowledge to which the term 'science' is applied is to be confined to the natural sciences, or to be extended to cover the humanities and social sciences as well. Some people use the word in both senses. Given the fact that the term science has been used in modern scholarship in its broadest sense of an academic or scientific discipline, as in Islamic tradition in which the Arabic term *'ulūm* (sciences) is used, we prefer to adopt this usage.[3]

Based on the above view, Islamic scholars themselves are called *ulama* (scientists), for their knowledge of the various fields of understanding within Islam, which includes, but are not limited to, theology (*aqidah*), jurisprudence (*fiqh*), mysticism (*tasawwuf*), etc. This broader definition of science as a "body of knowledge (in the sense of discipline),"[4] is further expounded upon by Alparslan Açikgenç as having essential aspects or content through which it is defined. These essential aspects are: (1) subject matter, (2) method, (3) theory, and (4) accumulated knowledge.[5]

The first aspect, known as the *subject matter*, is simply an "object of study" that "excludes all unrelated subjects of inquiry," determined by the conventions of the community attempting to learn about the object in question.[6] Following this is the aspect of *method*, or "the manner in which a scientific investigation is carried out," which may vary between disciplines.[7] The third aspect, known as theory, is "a formulation given as a provisional solution to a certain problem."[8] Açikgenç includes that a science can hold many theories for different problems and may even have 'super-theories', or doctrines which act as an umbrella for a cumulative number of theories addressing much more complex and intricate problems within the discipline.[9]

The final aspect that a science must have is that of *accumulated knowledge*, or the function of acquiring new information which can be named and organised, and which promotes the construction of a community of scholars that study the science in question.[10] In other words, in order to be a science, it must become a tradition of acquiring knowledge about the object it studies.

According to the above, anything may be considered a 'science' as long as it has these attributes. What makes one science different from another is simply the subject matter which it is concerned with. However, the types of subjects considered worthy of being considered 'science', as well as the problems which they seek to address, may differ depending on the axiological motivations towards creating a scientific tradition.[11] For instance, the content of a purely secular science may differ tremendously in its goals and output with one which is more religious, because the values of the scientists of both traditions differ. As such, an 'Islamic Science' is one which takes place within the context of the worldview of Islam,

projecting it through the values of the Muslim scientists at work.[12] However, not all worldviews are equal in the sense of aiding in the construction of a scientific tradition. Although all societies have some form of tradition of knowledge, or compilation of considered facts about the world they live in and their values, this does not necessitate that a science will necessarily be built around this tradition. It is outside the scope of this paper to give a full account of the differences between non-scientific worldviews versus scientific ones, however, it can be said that the above mentioned aspects that make up a 'science' must be inherently possible within a worldview prior to the rise of a scientific tradition. Any worldview that discredits or makes impossible any of the above mentioned aspects cannot ever produce science in the broadest sense of the term.

However, the focus of this paper is not on the broadest sense of the term 'science', although the topic is within the context of Muslim world history. While the broader definition is utilised among Muslim scholars – and is influential in the grand scheme of reviving the Muslim word in 'scientific productivity' – this notion of science is not their major concern when speaking about its rise, decline, and stagnation; it is in reference to the more narrow definition mentioned prior. Likewise, this research adopts the latter understanding of the term.

After having clarified the construct of 'science', it is imperative to this discourse to understand the terms representing the major influences behind the rise, decline, and stagnation of science in any given civilisation. These influences can be divided into two categories: *internal* and *external*.

Historian of science Tony Huff considers internal influences to be "methods, theories, paradigms, and instrumentation of science," and external influences as being "cultural and institutional structures that give scientific inquiry a secure place in the intellectual life of a society and civilisation."[13] However, Huff's categorisation is in no way exhaustive, as it does not include other external influences outside of the context or will of the civilisation being analysed; for instance, the impact of natural disasters on a society, uninvited warfare, or geographical and economic disadvantages. While Huff does engage with these other factors when discussing the rise, decline, and stagnation of a particular scientific tradition, his focus on the purely internal and external influences *within* a civilisation taints the integrity of his work, especially when speaking about Islamic civilisation, as will be evidenced later in this discussion.

Following the above, a cursory analysis of the history behind the rise and decline of science in Islamic civilisation will be given. While it is not within the scope of this paper to elucidate a full picture of the various opinions surrounding these points in history, a summary of the popular narrative and the problems associated with it shall be explained so as to give a clearer picture as to some of the major internal and external influences behind the rise and decline.

The 'Classical Narrative' and its Dissent

Research centred on the phenomena of rise, decline, and stagnation of scientific productivity in Islamic civilisation and the contemporary Muslim world often projects the popular conception developed over time by many historians writing and lecturing on the subject. This popular conception, mostly promulgated by Orientalists,[14] is referred to as the 'classical narrative' by historian George Saliba;[15] an Arab Christian who has made great strides in deconstructing the former narrative and its biases.

Saliba summarised the major assumptions made by the classical narrative in terms of rise and decline in his monumental work, *Islamic Science and the Making of the European Renaissance*:

> The narrative seems to start with the assumption that Islamic civilization was a desert civilization, far removed from urban life, that had little chance to develop on its own any science that could be of interest to other cultures. This civilization began to develop scientific thought only when it came into contact with other more ancient civilizations, which are assumed to have been more advanced … the Greco-Hellenistic civilization on the western edge of, and overlapping with the geographical domain of the Islamic civilization, and the Sasanian (and by extension the Indian) civilization. These surrounding civilizations are usually endowed with considerable antiquity, with high degrees of scientific production (at least at some time in their history), and with a degree of intellectual vitality that could not have existed in the Islamic desert civilization.
>
> This same narrative never fails to recount an enterprise that was indeed carried out during Islamic times: the active appropriation of the sciences of those civilizations through the wilful process of translation….In this context, very few authors would go beyond the characterization of this Islamic golden age as anything more than a re-enactment of the glories of Ancient Greece, and less so the glories of ancient India or Sasanian Iran. Some would at times venture to say that Islamic scientific production did indeed add to the accumulated body of Greek science a few features, but this addition is usually not depicted as anything the Greeks could not have done on their own had they been given enough time…. The classical narrative, however persists in imagining that the Islamic science that was spurred by these extensive translations was short-lived as an enterprise because it soon came into conflict with the more traditional forces within Islamic society, usually designated as

> religious orthodoxies of one type of another. The anti-scientific attacks that those very orthodoxies generated are supposed to have culminated in the famous work of the eleventh-twelfth-century theologian Abū Ḥāmid al-Ghazālī.[16]

Saliba rejected this understanding of the rise and decline of science in Islamic civilisation as a Western projection of its own history with the Church; a war between rationalism and traditional religious thought.[17] This perception is indicative in the narrative's double standards of giving absolutely no credit for the rise of science to the internal influence of the religion of Islam, all the while making it the main culprit of its demise.

The Canadian Islamic scholar Muzzafar Iqbal noted that this projection can be traced back to the Hungarian Orientalist Ignaz Goldziher[18] and his work, "The Attitude of Orthodox Islam towards the Ancient Sciences." Goldziher's paper, as evidenced from the title, emphasises the attitudes of religious scholars towards the so-called 'foreign sciences' of the Greeks and Persians as being wholly negative, based on the latter's supposed contradictory nature towards cherished doctrines of the faith. His thesis would gain popularity and eventually become the backdrop for the 'classical narrative'. That is why there are journalists writing that "Islamic civilisation did not have a culture hospitable to the advancement of science"[19] and astrophysicists and popular science educators like Neil deGrasse Tyson who echoes the idea that al-Ghazālī's instrumentalist[20] belief that "manipulating numbers is outside of your spiritual responsibilities and that all the events around you are the will of Allah,"[21] was ultimately responsible for the decline of scientific productivity among Muslims.

Along with the lay-community, historians have not been immune from the influences of Goldziher. For instance, Tony Huff – mentioned earlier – credited the former as a major influence numerous times in his work, *The Early Rise of Modern Science: Islam, China, and the West*. Huff was not hesitant to carry on the former's ideas:

> If in the long run scientific thought and intellectual creativity in general are to keep themselves alive and advance into new domains of conquest and creativity, multiple spheres of freedom – what we may call *neutral zones* – must exist within which large groups of people can pursue genius free from the censure of political and religious authorities. In addition, certain metaphysical and philosophical assumptions must accompany this freedom. Insofar as science is concerned, individuals must be conceived as being endowed with reason, the world may be thought to be a rational and consistent whole, and various levels of universal representation, participation, and discourse must be available.

> It is precisely here that one finds the great weaknesses of Arabic-Islamic civilization as an incubator of modern science.[22]

Huff's reliance on Goldziher's thesis reflects his bias towards the religious thought and institutions of Islamic civilisation – going so far as to parrot the phrase "Arabic sciences" so as to focus on the linguistic characteristics of the translation movement over any perceived influence of religion on scientific productivity during the period. According to Huff and others, the only positive contribution by the Muslims during this period was their unified language, which only facilitated the learning, preservation, and wholesale copy of Greek thought, which was later to be destroyed by the religiously anti-scientific spirit within. However, one has to wonder how such learning, preservation, or supposed wholesale copying of Greek thought would have been possible if anti-scientific sentiments existed prior to and during the translation movement; if 'foreign sciences' were already not welcome because of the intrinsic nature of Islam, then it is difficult to ascertain how they were tolerated to begin with and for so long.

Despite the impact and popularity of the above conflict-bound thesis, there has been a rise of historians realising the anomalies in Goldziher's research, suggesting that his thesis was possible only by "quoting remarks out of context from Islamic texts and by presenting them as delivering one single message."[23] Scholars such as Sonja Brentjes,[24] Dimitri Guntas,[25] Ahmad Dallal,[26] and George Saliba have attempted to offer more nuanced and evidence-based perspectives on the scientific tradition in Islamic civilisation – the last of whom offers the most salient deconstruction and alternative to the above-mentioned narrative.

The Alternative Rise

Saliba offers a very different account in contrast to the classical narrative; positing rather that the rise of science within Islamic civilisation was less an accidental appropriation of Greek thought through translation and more a product of an already scientific intellectualism intrinsic to the culture. While he offers several evidences for his position this paper shall only summarise his findings.

Saliba began his deconstruction of the popular conception of the rise of science in Islamic civilisation by first addressing *when* it actually commenced – as opposed to the classical narrative's assumption that it was spurred by the sudden genesis of the translation movement during the reign of the Abbāsid caliph, al-M'amūn (813-833 CE). According to legend, al-M'amūn had a mystical-like experience through a dream where he met Aristotle, who informed him that he should begin learning the sciences of the ancient Greeks.[27] Although this story is an unconfirmed account and most likely a mythological, post-hoc explanation, supporters of the classical narrative still include it in their research and attempt

to pinpoint around this time when the sciences were miraculously born in Islamic civilisation and what influenced it.

However, Saliba believes that the period of the rise was much earlier, and constructed his opinions based on the 10th century Persian Muslim historian Abū al-Faraj Muhammad b. Abī Ya'qūb Isḥāq al-Nadīm, who wrote *al-Fihrist* in 987 or 988 CE; an intellectual history of Islamic civilisation up to his period.[28] Al-Nadīm was the first to propagate the story that the Persian elements of Islamic civilisation were the main influences behind the desire for science – an attempt perhaps at bolstering his own cultural identity? However, many of the stories he relates are apocryphal, for he even included the story of al-M'amūn's dream.

Saliba contested that al-Nadīm was simply recording popular accounts of the day, and that he did not intend for them to be used as a necessary means to derive an historical account.[29] Even the Orientalists use of al-M'amūn's dream experience is viewed differently from al-Nadīm; the latter saw the dream as having impact on the spread of scientific knowledge, but not its initial motivation or source.[30] Similarly, al-Nadīm contradicts the classical narrative by asserting that the Byzantines could not have possibly "passed down" Greek learning to the Muslims, because the former had no interests in learning the sciences and considered their own ancient works as irrelevant[31] – meaning, the Muslims desired to learn about the sciences and to translate these texts. This suggests that the Muslims themselves were scientifically inclined – and learned to an extent – prior to their contact with the Greek texts. How else could they have known about them and sought them out, had they not already been aware of their value? As Dallal states:

> This translation movement provided the knowledge base of the emergent sciences. But while this explains part of the picture, and admittedly one of its most important parts, it does not provide a full explanation of the beginnings. To start with, what are the socio-political conditions and the cultural aptitudes that triggered interests in the translation and science in the first place? Second, what were the cultural conditions and the cultural aptitudes that enabled a significant community of interest to know how to translate complex scientific texts, to develop the technical terminology needed for the transfer of scientific knowledge between two languages, to understand scientific texts once they were translated, and to constructively engage the knowledge derived from them? Seen in this light, translation is not a mechanical process but part of a complex historical process that is not reducible to the transfer of external knowledge; rather, it involves forces intrinsic to the receiving culture – most important, the epistemological conditions internal to Islamic culture at the time of the translations.[32]

However, al-Nadīm's account of the rise of science in Islamic civilisation doesn't end at anecdotes, but concludes with a final, more realistic story which Saliba considered was his own opinion on the subject.

Al-Nadīm recounted a story where Khālid b. Yazīd b. Mu'āwiya – "a lover of science" – had ordered some Greek scientists who had mastered Arabic to translate works on alchemy. This short tale – for which there is little explanation beyond the above – is considered by al-Nadīm to be the first attempt at translation. Following this account, al-Nadīm mentioned the translation of the *diwan* (record of government revenues)[33] by Khalid's contemporary and superior, Hisham b. 'Abd al-Malik, the Umayyad caliph who ruled from 724 to 743 CE.[34]

The first part of the story is not precisely explained by al-Nadīm, other than by the mention of Khālid's love of science. However, external sources indicate that Khalid was ordered by 'Abd al-Malik to begin the translation of works on alchemy based on the need to mint independent metal coinage. This was due to the fact that 'Abd al-Malik wanted to no longer depend on Byzantine and Persian currencies.[35] This pragmatic concern, based on the values of the Islamic state, was the primary motivation behind the desire to learn alchemy. Likewise, al-Nadīm noted that the diwan was translated for a similar pragmatic goal, in that government revenues constituted the foundation of its operational fortitude. The reasons for the *diwan* being in Persian seems to be tied to the fact that the Persians were more apt at "handling arithmetical operations carried over fractions and the like," which were required in order to produce such a record.[36] As such, 'Abd al-Malik insisted on 'Arabising' the *diwan* for better function of the state and its flow of wealth. However, this process would eventually lead to a necessity for a larger acquisition of the sciences, since the recorders of the diwan not only required skills in arithmetic, but also of astronomy for being able to know on which date taxes were to be taken, geometry for land surveying, the knowledge of weights and measures for the collection of commodities, and much more.[37] This very important government position then became the springboard for deciding which other scientific texts were to be retrieved and translated. Likewise, other sciences were learned in order to fulfil certain job functions and necessities for the newly found Islamic empire. Most importantly, practicalities related to religious practice or *ibadah*, were more efficiently able to be carried out as a result of learning these sciences. For example, if one learned astronomy, knowing the specific times for obligatory acts of worship, such as the times for prayer (*salat*), when the month of fasting (*Ramadan*) would begin and end, and the period of religious holidays (*Eid*), would become much easier to predict, therefore effectively organising and administrating the most essential aspects of the Muslim societies' core activities and values.

Given the above, the translation movement did not just happen suddenly with the Abbāsids, but was set in motion prior by the Umayyads for practical reasons related to the values of the Islamic polity at that time; knowledge acquisition was necessary for better functioning of the state, which along with it developed greater efficiency for the society as a whole, whose Islamic identity was intrinsically tied with the former. In other words, the *internal influence* of Islamic values was the prime motivating factor behind the translation movement, and ultimately towards the acquisition of the sciences.

The strong emphasis the Qur'an places on the quest for truth has also played an important role in the advancement of scientific enquiry by Muslims. There are also various evidences from both the Qur'an and Sunnah indicating that knowledge acquisition in general is a noble cause in subservience to Allah and the raising of one's status in the after-life. Among these evidences, the Qur'an clearly commends those who try to obtain knowledge of the physical world as being a way towards wisdom and devotion to Allah:

> Surely in the creation of the heavens and the earth and in the alternation of the night and the day there are signs for men possessed of minds who remember God, standing and sitting and on their side, and reflect upon the creation of the heavens and the earth…[38]

The Prophet Muhammad (*sallAllahu alayhi wasallam*) preached to the same effect, emphasising the virtues of obtaining knowledge:

> The seeking of knowledge is obligatory for every Muslim.[39]

> A servant of God will remain standing on the Day of Judgment until he is questioned about his (time on earth) and how he used it; about his knowledge and how he utilized it ....[40]

> Knowledge from which no benefit is derived is like a treasure out of which nothing is spent in the cause of God.[41]

> Acquire knowledge and impart it to the people.[42]

This understanding also eliminates idealistic notions of knowledge acquisition "for its own sake" or by way of "accident"; both preached by Orientalists, especially when attempting to force into history the tenuous view that the more 'rationalist' understanding of Islam – known as *Mu'tazilitism* – was responsible for the translation movement and the subsequent rise of science in Islamic civilisation. This view not only discounts many of the evidences proposed by scholars such as Saliba, but relies on a very short-lived reign by the so-called 'rationalists',

which lasted only between 813 and 847 CE and was eventually overturned by the more traditional elements of society later.[43] As such, the supporters of the 'classical narrative' must formulate a more substantial justification for the rise and decline of scientific progress in Islamic civilisation rather than on the rule of a minority position that had less than a 40 year lifespan. While there is no doubt that the Mu'tazilites may have had some impact on Muslim thought, it is difficult to believe that they were solely responsible for all scientific advances over a seven century period.

But what of the external influences at play? It would seem that the rise of science was also predicated on the environment in which the Muslims lived at the time. The desire to acquire these sciences and to translate was spurred not only by the values inherent within Muslims, but also by the conditions which may have provoked such decisions; the desire to function through the unification of language, and to progress, could have well been influenced by the desire to survive and compete with other warring empires, such as the Byzantines and Persians, which engulfed the Islamic polity on both sides till they were conquered later. This effect of *isolation*, which will be discussed later, drove Muslims to look inward, creating a unified – linguistically and ideologically – state that would later be able to incorporate and even alter foreign ideas and civilisations.

Decline and the 'Age of Dependency'

If the classical narrative cannot account for the rise of science in Islamic civilisation based on the poor assumptions of a 'conflict between religion and science', then it certainly cannot account for its decline. Evidence already points in the direction that, rather than restricting scientific thought, the more conservative elements of Islamic tradition allowed for it to thrive freely without much limitation.

However, the model of the European experience with the Church was transferred fluidly onto Islamic history without concern for the differences in culture or ideology, thus making it far easier for the West to essentialise, and ultimately demonise, many aspects of Islamic civilisation without the faintest clue of the realities or the need to study them. As such, it remains a convincing myth that only seems to cultivate a complex of superiority in the internal influences of a particular culture; that is the West.

Saliba noted that one of the main targets of the promoters of the classical narrative is Abu-Hamid al-Ghazālī, whom they lay the burden of the decline of science. Al-Ghazālī is often blamed in this respect because of his refutation of the Aristotelian philosophers within Muslim society during the 12th century CE, through his now famous work, *The Incoherence of the Philosophers* (*Tahāfut*

al-Falāsifa). It is argued that as al-Ghazālī's treatise eventually became popular, it buttressed more traditional and mystical elements of the faith at the expense of the more 'rational' and scientific variations of Islamic thought. His main argument, as many Orientalists would have one believe, was his refutation of one of the foundational concepts of scientific inquiry: the necessity between cause and effect, although such a necessity is doubtful in certain sciences today, such as Quantum Physics.

Al-Ghazālī's apparent disregard for causality, for the sake of undermining the philosopher's heretical theological beliefs of an eternal universe, would eventually lead others to abandon the scientific enterprise all-together, thinking that because God is in control of all things in their causes and effects – known as 'occasionalism' – there is no need to pursue scientific knowledge. Despite this being a clear non-sequitur,[44] especially in light of contemporary science, it is an objection that holds virtually no merit because scientific productivity continued to thrive long well after the publication of al-Ghazālī's treatise, up until the 16th century.

Saliba catalogues several important scientific discoveries, well advanced beyond previous generations, which occurred centuries after *The Incoherence*. Although these discoveries are at the individual level and don't appear to be developed by any institutionalised initiatives, they still reflect a scientific mentality prevalent within society and one which had no real restrictions. For instance, Saliba noted the discoveries of scholars such as Ibn al-Nafīs, the 13th century medical practitioner who discovered the circulation of blood,[45] and Kamal al-Din al-Farisī of the 14th century, who advanced beyond the science of optics of his more famous predecessor, Ibn al-Haytham – also known as the "father of the scientific method."[46] Al-Farisī was the first person to understand how the colours of a rainbow were produced by creating his own instruments to observe the phenomenon.[47] However, perhaps the greatest discoveries were made in astronomy, leading to a thorough critique of the Ptolemaic system, which would pave the way for Copernicus to create a necessary paradigm shift in the understanding of the revolution of the planets and our solar system. All of this is evidenced in the sophisticated commentaries produced by the likes of the 16th century astronomer, Shams al-Dīn al-Khafirī.[48] In other words, the 'post-Ghazālī' centuries were ripe with scientific discoveries and treatises that would eventually influence the European understanding of these fields.

Al-Ghazālī's innocence is more profoundly understood in the context of his actual thoughts on causality. Although it can be admitted that al-Ghazālī may have been overzealous and extreme in some of his statements, many scholars have mistaken his views as anti-rationalist simply because he denied a necessary link between cause and effect. However, whether such a view can be blamed

for the decline in science is questionable, especially given the fact that he still believed the there was a necessary connection, but not as intrinsic quality of the things themselves:

> The connection between what is habitually believed to be a cause and what is habitually believed to be an effect is not necessary, according to us…Their connection is due to the prior decree of God, who creates them side by side, not to its being necessary in itself, incapable of separation.[49]

So the idea that al-Ghazālī was solely responsible for the decline of scientific productivity is unsubstantiated, especially given the fact that none of his thoughts were necessarily anti-scientific. It is further claimed that his apparent "dislike for non-instrumental sciences" may have also been a cause in the decline, although there is little to no evidence for this accusation, which appears to be nothing more than a projection of the internalist's understanding of 'knowledge for its own sake', a view that has never truly existed in the history of civilisations – knowledge has always been sought for ulterior motives, usually practical.

Following Saliba's deconstruction, he offers an alternative account of the period of decline, on the basis of events that occurred around the 16th century CE. During this period, evidence of several external influences come into play, such as the de-unification of the Islamic civilisation into three independent polities, the ongoing wars with the Western world, and the migration of the West across the Atlantic in search of new wealth and resources given the Muslim's monopolisation of trade routes and land in the southern and eastern parts of the European region.[50] Here, we begin to see the phenomena of decline manifesting itself, where educational institutions for the sciences began to wane and total dependency on foreign scientific discoveries, institutions, and technology began to take hold.[51] The reaction of Muslims to the new influx of resources and wealth into Europe, their own political division, and losing ground to Western military forces (such as in Vienna), may be better called the 'Age of Dependency', rather than decline, since science was still valued and sought after, but this time externally to one's own civilisational context.

Rather than looking inward for answers, Muslims took to expediency and quick results to advance their power so as to keep up with European progress. Instead of a patient and considered strategy to these new problems, the reaction resorted to the acquisition of innovations from Europe and elsewhere in a period where self-reliance, independence, and a true 'Islamic' science would eventually come to an end.

This 'Age of Dependency' manifested itself more prominently during the time of the Ottoman Empire, where the Turks attempted to modernise their societies

through European invention and ideas. It would eventually become the primary feature of Muslim majority societies during the colonial and post-colonial period, with Muslims adopting a perspective of science as the ultimate universal standard of truth and knowledge – known as positivism – motivated by their utmost degradation at the hands of Western forces for nearly two centuries.[52]

However, the internal aspects of this decline may have developed as early as around the beginning of the 15th century, with the political turmoil within the Andalusian caliphate and the various rebellions across the Muslim world. Al-Andalus would eventually fall by the 15th century to Christian forces and the rebellions would eventually lead to three separate Islamic polities competing for power. The intellectual climate and institutions to support science during this period may have been stifled dramatically due to the focus on political conflict and warfare within and external to Islamic civilisation. Although ideological factors have yet to be researched in detail, it is certain that they were a direct result of these other internal influences occurring during that time.

While Saliba has documented numerous discoveries beyond the 14th century C.E., showcasing that scientific ingenuity had not completely died off, were these merely the remnants of what was left of a scientific culture now no longer widely operative within Islamic civilisation as a whole? Had Muslims become victim to a positivistic understanding of science as a result of the glorification of past achievements based on the inability to pursue further research? Did this inability therefore become compensated by a synthesis between science and revelation?

Schemes of Revitalisation?

What can be said then of current attempts at revitalising scientific productivity in the Muslim world? Do these schemes reflect the historical realities of rise, decline, and stagnation, or do they reflect a post-colonial view of positivism, still entrenched in Western values and ideologies? Is the current attempt at Islamisation a viable concept, or does it suffer from an impractical understanding of the past and present? Though it is not within the scope of this research to study these questions, perhaps a comprehensive elucidation on the contemporary schemes of revitalisation need to be assessed, so as to come to an ideal solution that not only reflects an accurate historical picture of the 'Age of Productivity", but also of the 'Age of Dependency' which still remains a major defining aspect of the Muslim world.

Also, the Muslim world currently has no great example of scientific productivity or ingenuity, save one place that is often excluded on the basis that it represents a minority position in Islamic theology: Iran. This historical Persian nation has been known for being the centre stage of Western propaganda and war-mongering,

insinuating that it is a grave threat to the world. Countless sanctions and military efforts have placed Iran in a spot of isolation, forcing it to survive based on its own initiatives and desire to protect itself. As a result, Iran is now considered to be the fastest growing country in the world in scientific growth,[53] and has made several discoveries in the fields of nano-technology, medical technology, and military. Like Europe before, which was isolated from the rest of the world due to the monopolisation of trade and resources by the Islamic civilisation, Iran has had to make desperate decisions in order to survive. Has this forced isolation and instrumentalists variation of science become a proof for the alternative narrative proposed by Saliba, and likewise a model by which a scheme of revitalisation can be constructed? If so, how can it be emulated and put into practice across the Muslim world at large?

Conclusion

The above discussion has shed light on the realities of the phenomena of rise, decline, and stagnation in Islamic civilisation and the Muslim world, deconstructing the popular conception, known as the 'classical narrative', and offering a salient alternative based on contemporary and more nuanced studies.

Given this, this research offers the following policy recommendations for future initiatives and studies on the subject towards reviving scientific productivity in the Muslim world:

1. Firstly, re-educate the Muslim masses in terms of their history and the nature of science as a *pragmatic enterprise* – not a positivistic one. To achieve this, the 'classical narrative' needs to be exposed and disposed of once and for all and replaced with more nuanced and evidenced-based perspectives, such as those given in the previous discussion. Along with this, the phenomena known as 'rise', 'decline', and 'stagnation' should reflect a more sociological and value-laden perspective so as to bring awareness to the flaws of perception on this issue. This research recommends that 'rise' – and other labels such as 'golden age' – be replaced by "Age of Productivity", and 'decline' be replaced by "Age of Dependency", to reflect the behaviours of Muslim majority societies more accurately. Furthermore, schemes towards revitalisation need be further studied and should only be promoted if they cohere with historical and contemporary realities.
2. Studies on Iran's forced isolation and current surge of scientific growth should be more closely studied as a case example of how the Muslim world at large can further advance from its current stage.
3. Another necessary step towards reviving scientific productivity in the Muslim world is to make *hijra* away from dependency on Western systems.

This policy of *isolation* in no way resembles a complete closing off from other societies, nor does it encourage 'Islamisation', but rather ensures *independency* and *need*. In other words, there needs to be less dependency on foreign aid, foreign funding, foreign institutions, foreign ideas, and foreign languages. While the appropriation of other ideas can still occur, more solutions derived from Islamic values, and not carbon copies of the former with Islamic labels, need to be brought to the table. This can only be achieved by implementing policies at the government level to reformat a colonised system and mentality.

Notes

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1. Oxford Dictionaries. "Science," accessed March 15, 2015, http://www.oxforddictionaries.com/definition/english/science.
2. Oxford Dictionaries. "Technology," accessed March 15, 2015, http://www.oxforddictionaries.com/definition/english/technology.
3. Osman Bakar, *Tawhid and Science*, 2nd ed. (Shah Alam: Arah Publications, 2008), xxx-xxxi.
4. Quoted in, Alparslan Açikgenç, *Islamic Science: Towards a Definition* (Kuala Lumpur: International Institute of Islamic Thought and Civilisation, 1996), 35.
5. Alparslan Açikgenç, *Islamic Scientific Tradition in History* (Kuala Lumpur: IKIM, 2014), 12-15.
6. Ibid, 12.
7. Ibid, 13.
8. Ibid, 45.
9. Ibid, 45-46.
10. Ibid, 15.
11. Axiology is the philosophical study of values. The term 'axiological' here is being used in a very broad sense as meaning 'value tradition'. Açikgenç considers human values as essential to the rise of all scientific traditions, however, I believe he mistakenly labels this condition as 'moral sensitivity' (Ibid, 27.), given that morals are only one aspect of the values of a society and its motivation towards knowledge acquisition. Values are the cherished beliefs of a community which guide them in their affairs – morals are concerned primarily with right conduct, and do not necessarily move one towards knowledge acquisition.
12. Açikgenç, *Islamic Scientific Tradition in History*, 27.
13. Tony Huff, *The Rise of Early Modern Science: Islam, China, and the West*, 2nd ed. (Cambridge: Cambridge University Press, 2003), 19.

14. An Orientalists is broadly defined as "someone who studies the Orient [the east]." However, it is specifically being used here to refer to those who study the East through the lens of the Western bias known as 'Orientalism', which views Eastern cultures and religions as static, underdeveloped, and culturally inferior.
15. George Saliba, *Islamic Science and the Making of the European Renaissance* (Cambridge: The MIT Press, 2007), 1.
16. Ibid, 1-2.
17. Ibid, 234.
18. Muzzafar Iqbal, *The Making of Islamic Science* (Kuala Lumpur: Islamic Book Trust, 2009), 73.
19. Hillel Ofek, "Why the Arab World Turned Away from Science," *The New Atlantis*, Number 3 Winter 2011, accessed March 16, 2015, http://www.thenewatlantis.com/publications/why-the-arabic-world-turned-away-from-science
20. Instrumentalism is the view that scientific knowledge should ultimately have some sort of practical use and should not be studied for any other reason than to benefit society.
21. Stephen Shankland, "Neil DeGrasse Tyson: US need not lose its edge in science," *CNET*, June 20, 2014, accessed on March 16, 2015, http://www.cnet.com/news/neil-degrasse-tyson-the-us-doesnt-have-to-lose-its-edge-in-science/
22. Huff, *The Rise of Early Modern Science*, 219.
23. Sonja Brentjes, "Reviews: Oversimplifying the Islamic Scientific Tradition", *Metascience 13* (2004): 83-86, accessed on March 17, 2015, https://www.academia.edu/1335377/Oversimplifying_the_Islamic_Scientific_Tradition_Metascience_Volume_13_Number_1_83-86_DOI_10.1023_B_MESC.0000023270.62689.51, DOI: 10.1023/B:MESC.0000023270.62689.51
24. Sonja Brentjes, "On the Location of the Ancient or 'Rational' Sciences in Muslim Educational Landscapes (AH 500 – 1100)," *Bulletin of the Royal Institute of Inner-Faith Studies 4* (2002): 47-71, accessed on March 17, 2015, https://www.academia.edu/625038/On_the_Location_of_the_Ancient_or_Rational_Sciences_in_Muslim_Educational_Landscapes_AH_500_-1100_, DOI: NA.
25. Dimitri Gutas, *Greek Thought, Arabic Culture: The Graeco-Arabic Translation Movement in Baghdad and Early 'Abbasaid Society* (2^{nd}-4^{th}/5^{th}-10^{th} c.) (New York: Routledge, 1998).
26. Ahmad Dallal, *Islam, Science, and the Challenge of History* (New Haven: Yale University Press, 2010).
27. Saliba, *Islamic Science and the Making of the European Renaissance*, 13.
28. Ibid, 28.
29. Ibid, 40.
30. Ibid, 52.
31. Ibid, 42-44.
32. Dallal, *Islam, Science, and the Challenge of History*, 10-11.
33. Ibid, 54.
34. Saliba, *Islamic Science and the Making of the European Renaissance*, 45-46.
35. Ibid, 50-51.
36. Ibid, 53.
37. Ibid, 54-55.
38. Al-Qur'an, Surah al-Imran (3:190-191).

39. Al-Tirmidhi, Hadith # 74
40. Al-Tirmidhi, Hadith # 148
41. Al-Tirmidhi, Hadith # 108
42. Al-Tirmidhi, Hadith # 107
43. Saliba, *Islamic Science and the Making of the European Renaissance*, 13-14.
44. Meaning "the conclusion does not follow logically from the premises".
45. Saliba, *Islamic Science and the Making of the European Renaissance*, 239.
46. Ross Pomeroy, "Ibn al-Haytham: The Muslim Scientist Who Birthed the Scientific Method," *Real Clear Science*, March 25, 2014, accessed on March 16, 2015, http://www.realclearscience.com/blog/2014/03/the_muslim_scientist_who_birthed_the_scientific_method.html
47. Saliba, *Islamic Science and the Making of the European Renaissance*, 239.
48. Ibid, 240.
49. Quoted in, Hamid Zarkaysi, *Al-Ghazali's Concept of Causality: With Reference to His Interpretations of Reality and Knowledge* (Gombak: IIUM Press, 2010), 210-211.
50. Saliba, *Islamic Science and the Making of the European Renaissance*, 249-255.
51. Ibid, 247.
52. Positivism was formally introduced into the Muslim world by Jamāl al-Dīn al-Afghāni, the so-called 'Islamic reformist' of the 20th century, who agreed with many of the positivistic critiques of the Muslim world by French Orientalist Ernest Renan. Renan argued that Muslims (and Arabs) lagged in science because of the very inherent nature of Islam being opposed to the universal, objective nature of science. Al-Afghāni responded to Renan, agreeing about the nature of science, but that Islam was inherently welcoming to it. Al-Afghāni's perspective would later be adopted by the majority of Muslim society, spurring popular ideas about how there are 'scientific miracles' in the Qur'an.
53. Shahin Akhondzadeh, "Iranian science shows world's fastest growth: ranks 17th in science production in 2012," *Avicenna Journal of Medical Biotechnology* (5)3 (2013): 139, accessed on March 17, 2015, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3732862/